Potential natural vegetation of Eastern Africa (Ethiopia, Kenya, Malawi, Rwanda, Tanzania, Uganda and Zambia). Volume 4

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VOLUME 4

Description and Tree Species Composition for Bushland and Thicket Potential Natural Vegetation Types

R. Kindt, P. van Breugel, J.-P. B. Lillesø, M. Bingham, Sebsebe Demissew, C. Dudley, I. Friis, F. Gachathi, J. Kalema, F. Mbago, V. Minani, H.N. Moshi, J. Mulumba, M. Namaganda, H.J. Ndangalasi, C.K. Ruffo, R. Jamnadass and L. Graudal

FACULTY OF LIFE SCIENCES
UNIVERSITY OF COPENHAGEN

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Authors
Kindt, R., van Breugel, P., Lillesø, J.-P. B., Bingham, M., Sebsebe Demissew, Dudley, C., Friis, I., Gachathi, F., Kalema, J., Mbago, F., Minani, V., Moshi, H. N., Mulumba, J., Namaganda, M., Ndangalasi, H.J., Ruffo, C. K., Jamnadass, R. and Graudal, L.

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University of Copenhagen
23 Rolighedsvej
DK-1958 Frederiksberg
sl@life.ku.dk
+45-33351500

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Introduction

This book represents Volume 4 in a seven-volume series that documents the potential natural vegetation map that was developed by the VECEA (Vegetation and Climate change in East Africa) project. The VECEA map was developed as a collaborative effort that included partners from each of the seven VECEA countries (Ethiopia, Kenya, Malawi, Rwanda, Tanzania, Uganda and Zambia).

- In **Volume 1**, we present the potential natural vegetation map that we developed for seven countries in eastern Africa. In Volume 1, we also introduce the concept of potential natural vegetation and give an overview of different application domains of the VECEA map.
- **Volumes 2** to **5** describe potential natural vegetation types, also including lists of the "useful tree species" that are expected to naturally occur in each vegetation type – and therefore also expected to be adapted to the environmental conditions where the vegetation types are depicted to occur on the map. **Volume 2** focuses on forest and scrub forest vegetation types. **Volume 3** focuses on woodland and wooded grassland vegetation types. **Volume 4** focuses on bushland and thicket vegetation types. In **Volume 5**, information is given for vegetation types that did not feature in Volumes 2 to 4.
- **Volume 6** gives details about the process that we followed in making the VECEA map.
- **Volume 7** shows the results of modelling the distribution of potential natural vegetation types for six potential future climates.

Erratum (May 18, 2020): Authorships, localities and dates of photographs have been corrected in the figure captions for 9 different photos in volumes 2, 4, 5, 8, 9, 10, and 11.

Volume 2 Forest	Figures 6.1; 6.2; 20.1
Volume 4 Bushland	Figures 4.7; 7.4; 7.5; 7.8
Volume 5 Other	Figures 3.5; 4.2; 5.4
Volume 8 Kenya	Figures 8.1; 8.2; 16.1; 25.7; 26.4; 26.5; 26.6; 28.5; 29.2; 30.4
Volume 9 Rwanda	Figures 7.1; 7.2; 10.1; 14.7; 15.4; 15.5; 15.6; 16.5; 17.2
Volume 10 Tanzania	Figures 8.1; 8.2; 16.1, 26.7, 27.4; 27.5; 27.6; 30.5; 31.2
Volume 11 Uganda	Figures 8.1; 8.2; 11.1; 20.7; 21.4; 21.5; 21.6; 22.5; 23.2

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Thanks to Eugene Kayijamahe, Center for Geographic Information System and Remote Sensing at National University of Rwanda for sharing the digital map "Vegetation of Volcanoes National Park" that allowed us to classify in greater detail this part of the VECEA map.

Thanks to UNEP-GEF for funding the Carbon Benefits Project (CBP) through which information was compiled on indicator and characteristic species for The Vegetation Map of Africa (White 1983). (This work led to the publication in 2011 of an Africa-wide tree species selection tool that is available from: *http://www.worldagroforestrycentre.org/our_products/databases/ useful-tree-species-africa)* Thanks to BMZ for funding the ReACCT project in Tanzania through which funding was made available for field verification of the VECEA map around Morogoro (this was essential in preparing the VECEA map as the base map for Tanzania was essentially a physiognomic map.

Abbreviations

Abbreviation	Full
A	Afroalpine vegetation
B	Afromontane bamboo
Bd	Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket
Be	Evergreen and semi-evergreen bushland and thicket
bi (no capital)	Itigi thicket (edaphic vegetation type)
br (no capital)	Riverine thicket (edaphic vegetation type, mapped together with riverine forest and woodland)
C	In species composition tables: we have information that this species is a characteristic (typical) species in a national manifestation of the vegetation type
D	Desert
DBH	diameter at breast height (1.3 m)
E	Montane *Ericaceous* belt (easily identifiable type)
f (no capital)	In species composition tables: since this species is present in the focal country and since it was documented to occur in the same vegetation type in some other VECEA countries, this species **potentially** occurs in the national manifestation of the vegetation type
Fa	Afromontane rain forest
Fb	Afromontane undifferentiated forest (Fbu) mapped together with Afromontane single-dominant *Juniperus procera* forest (Fbj)
Fc	Afromontane single-dominant *Widdringtonia whytei* forest
fc (no capital)	Zanzibar-Inhambane scrub forest on coral rag (edaphic forest type)
Fd	Afromontane single-dominant *Hagenia abyssinica* forest
Fe	Afromontane moist transitional forest
fe (no capital)	Lake Victoria *Euphorbia dawei* scrub forest (edaphic forest type mapped together with evergreen and semi-evergreen bushland and thicket)
FeE	distinct subtype of Afromontane moist transitional forest in Ethiopia
FeK	distinct subtype of Afromontane moist transitional forest in Kenya
Ff	Lake Victoria transitional rain forest
Fg	Zanzibar-Inhambane transitional rain forest
Fh	Afromontane dry transitional forest
Fi	Lake Victoria drier peripheral semi-evergreen Guineo-Congolian rain forest
FLD	Forest & Landscape (URL *http://sl.life.ku.dk/English.aspx)*
Fm	Zambezian dry evergreen forest
Fn	Zambezian dry deciduous forest and scrub forest
Fo	Zanzibar-Inhambane lowland rain forest
Fp	Zanzibar-Inhambane undifferentiated forest
Fq	Zanzibar-Inhambane scrub forest
fr (no capital)	Riverine forests (edaphic forest type mapped together with riverine woodland and thicket)
Fs	Somalia-Masai scrub forest (mapped together with evergreen and semi-evergreen bushland and thicket)
fs (no capital)	Swamp forest (fs, edaphic forest type)
G	Grassland (excluding semi-desert grassland and edaphic grassland)
g (no capital)	Edaphic grassland on drainage-impeded or seasonally flooded soils (edaphic vegetation type)
gv	Edaphic grassland on volcanic soils (edaphic subtype)
ICRAF	World Agroforestry Centre (URL *http://www.worldagroforestry.org/*)
L	Lowland bamboo
M	Mangrove
P	Palm wooded grassland (physiognomically easily recognized type)
PROTA	Plant Resources of Tropical Africa (URL *http://www.prota.org/*)
S	Somalia-Masai semi-desert grassland and shrubland

s (no capital)	Vegetation of sands (edaphic type)
T	*Termitaria* vegetation (easily identifiable and edaphic type, including bush groups around *termitaria* within grassy drainage zones)
UNEP	United Nations Environment Programme (URL *http://www.unep.org/*)
VECEA	Vegetation and Climate Change in Eastern Africa project (funded by the Rockefeller Foundation)
Wb	*Vitellaria* wooded grassland
Wc	Combretum wooded grassland
Wcd	dry *Combretum* wooded grassland subtype
Wcm	moist *Combretum* wooded grassland subtype
WCMC	World Conservation Monitoring Centre (URL *http://www.unep-wcmc.org/*)
wd (no capital)	Edaphic wooded grassland on drainage-impeded or seasonally flooded soils (edaphic vegetation type)
We	Biotic *Acacia* wooded grassland
Wk	Kalahari woodland
Wm	Miombo woodland
Wmd	Drier miombo woodland subtype
Wmr	Miombo on hills and rocky outcrops subtype
Wmw	Wetter miombo woodland subtype
Wn	north Zambezian undifferentiated woodland and wooded grassland (abbreviation: undifferentiated woodland)
Wo	Mopane woodland and scrub woodland
wr (no capital)	Riverine woodland (edaphic vegetation type, mapped together with riverine forest and thicket)
Wt	*Terminalia sericea* woodland
Wvs	*Vitex - Phyllanthus - Shikariopsis (Sapium) - Terminalia* woodland (not described regionally)
Wvt	*Terminalia glaucescens* woodland (not described regionally)
Wy	Chipya woodland and wooded grassland
X	Fresh-water swamp
x (no capital)	In species composition tables: we have information that this species is present in a national manifestation of the vegetation type
Z	Halophytic vegetation
ZI	Zanzibar-Inhambane coastal mosaic (Kenya and Tanzania coast)

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1. Definition of bushlands and thickets

Bushlands are open stands of bushes (usually between 3 and 7 m tall) with a canopy cover of 40 percent or more. **Thickets** are closed stands of bushes (usually between 3 and 7 m tall) where the bushes are so densely interlaced that they are impenetrable - except along tracks made by animals. In most types of bushland, larger or smaller patches of thicket occur without significant changes in species composition. Bushlands and thickets have smaller height than **woodlands** that are defined as open stands of trees of at least 8 m tall with a canopy cover of 40 percent or more. Bushlands and thickets are taller than **shrublands** defined as open or closed stands of shrubs up to 2 m tall (White 1983 p. 46).

Bushlands and thickets have greater canopy cover than **wooded grasslands** which are defined by cover percentages of woody plants (including trees, bushes, dwarf trees, shrubs or palm trees) of 10 to 40 percent (White 1983 pp. 46 and 49). Where bushes occur in a continuous sward of grasses, this vegetation type could be described as "bushed grassland". However, White (1983) included bushed grassland in the more general physiognomic type of wooded grasslands. Where cover percentages of bushes are less than 40 percent but grasses are sparse (such as rocky or stony places that are unsuitable for grasses), it is inappropriate to use the physiognomic category of "bushed grassland" or "wooded grassland". In these situations, it is more appropriate to classify these vegetation types as "open bushlands" (White 1983 pp. 46 and 49; see also the description of Somalia-Masai *Acacia-Commiphora* deciduous bushland [Bd]).

In the VECEA map, we follow White (1983) in not classifying **bamboo** (B and L in the VECEA map) as a subtype of thickets, but as a distinct physiognomic category (*i.e.* classified as one of the other vegetation types described in volume 5).

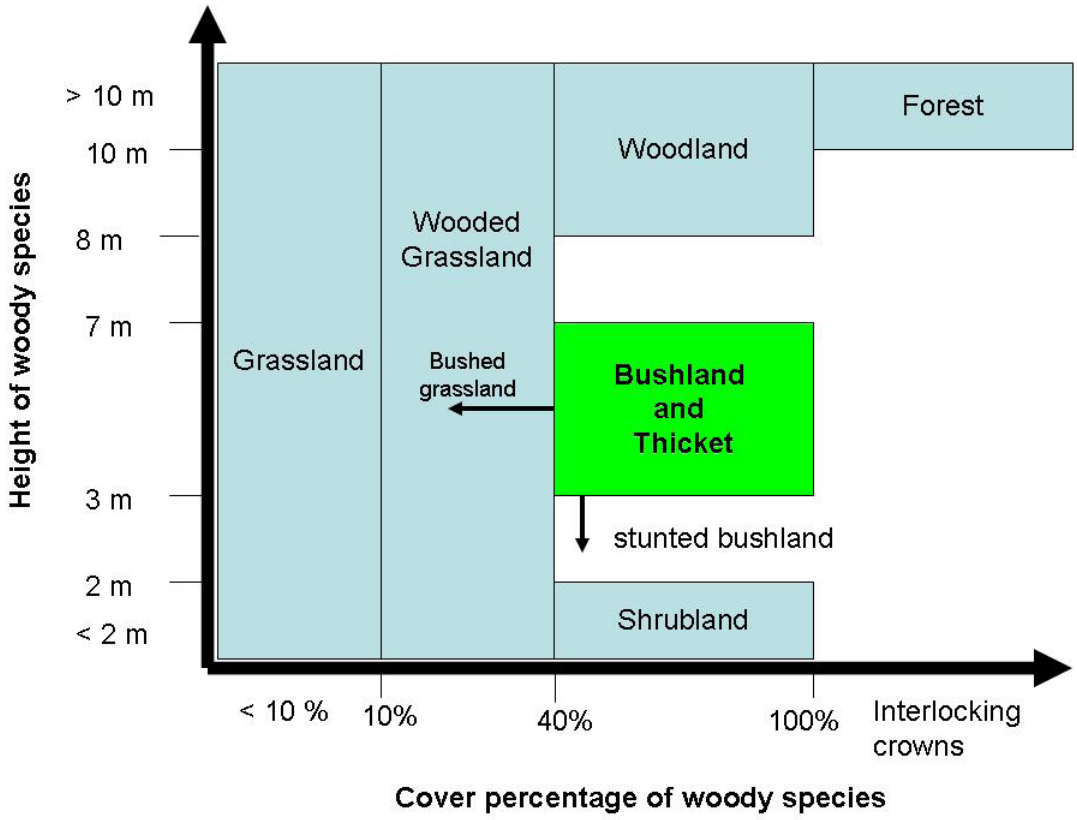


Figure 1. Height and cover percentage limits for major physiognomic types. Bushed grasslands is a subtype of wooded grassland. Open bushlands (not shown) has cover percentages below 40% but grass cover is not sufficient to classify as a subtype of wooded grassland.

2. Methodology

2.1. Main description of a bushland or thicket type

In these sections, we relied heavily on *The Vegetation of Africa* (White 1983) - especially since this reference built on the extensive expertise that White (1983) and his co-authors obtained from literature (including 2400 references) and field work (including the experience from many reviewers [White 1983 p. 13]). By comparing species composition described at national (or subnational levels) with species composition described at a continental level, we were seeking to identify potential natural vegetation types of continental relevance that included the various national "manifestations" of these continental vegetation types. Moreover, we now expect to have set the stage for a potential further expansion of the VECEA map in other countries in Africa. **Within the structure of this volume, the first section ("description") within the description of a particular bushland or thicket type refers to the "regional information" that was mainly obtained from "The Vegetation of Africa" (White 1983).**

2.2. Information for the VECEA region

Other than key reference on The Vegetation of Africa (White 1983), we mainly consulted the references that were directly associated with the base maps that we used: Ethiopia, Kenya (two different maps), Rwanda (Bloesch *et al.* [2009] contains an updated version of the vegetation map prepared by Prioul [1981]; the latter is the vegetation map that we digitized (see volume 6), Uganda and Zambia. For two countries, information was limited and we therefore reverted to various other references: Malawi and Tanzania. **Within the structure of this volume, the second section ("VECEA region") within the description of a particular bushland or thicket type refers to information that was obtained from one of the national descriptions of the seven VECEA countries.**

The second section also explains the correspondence between the mapping units of the regional map (the VECEA map) and the national maps. For more details how the regional map was obtained from the national maps, see volume 6.

2.3. Information on species assemblages for a particular bushland or thicket type

For each of the bushland types, we obtained information on species assemblages (those tree species expected to occur in a particular bushland or thicket) based on information that was provided in the national references. For each of the countries where we had information on the national "manifestation" of a bushland type (for example, Somalia-Masai *Acacia-Commiphora* bushland and thicket as it was described for Ethiopia by Friis *et al.* 2010), we created a separate column within which we gave an indication that a particular tree species was expected to occur within that bushland type and within that country.

Where species were not listed in the national reference for a focal country, we checked with information on national lists of all the tree species that occur in the focal country [1] whether the species could **potentially** occur in the focal bushland type and focal country **because the species was documented to occur in the same bushland type in other countries**. For example, the species *Acacia brevispica* was documented to occur in Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket in the national references from Ethiopia, Kenya and Uganda. From the UNEP-WCMC species database and the Flora of Tropical East Africa, there was information that this species also occurs in Tanzania. This led us to indicate that there was information that the species **potentially** occurred in Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket in Tanzania (we used the coding of "f" in the species assemblage table to indicate this). **Note that it is possible that species indicated with "f" for a particular country and bushland type do NOT occur in that particular country and bushland type in reality (meaning that, in reality, differences exist between species assemblages of the same bushland type between countries – or possibly indicating errors in the obtained species assemblage for a particular country).**

We used a consistent naming system for all the species that were listed in this volume. Information on synonyms (see Appendix 2) was mainly obtained from the African Plants Database (URL *http://www.ville-ge.ch/musinfo/bd/cjb/africa*), whereas we generally attempted to use the same botanical names as adopted in the Plant Resources of Tropical Africa (PROTA) database (URL *http://www.prota4u.org/*). Generally we did not differentiate below the species level. Even though the type species of the *Acacia* genus has recently been modified to be an Australian species (previously the type species was *Acacia nilotica*), we will continue to use the name of *Acacia* (in its widest sense, i.e. combining *Senegalia* and *Vachellia*) in Africa.

After compiling information on species assemblages, we selected a subset of tree species to feature in species composition tables. These were mainly "useful tree species", which are forest, bushland or liana species that are expected to be useful to farming or pastoral communities in the VECEA countries (see Appendix 1).

1: These floristic references included the UNEP-WCMC species database, the Flora of Tropical East Africa (for Kenya, Tanzania and Uganda), the Flora Zambesiaca (for Malawi and Zambia), and some of the national references (Friis et al. [2010] for Ethiopia; Beentje [1994] for Kenya; Bloesch et al. [2009] for Rwanda; the Uganda Forest Department Biodiversity Database (Howard & Davenport [1996], Viskanic [1999]) for Uganda; and Burgess and Clarke 2000 for the coastal areas of Kenya and Tanzania)

The regional information (*i.e.* mainly obtained from White 1983) was used to collate information on the "regional status" of a species. The regional status included information on "indicators", "characteristic species" and "species that are not characteristic".

We defined these categories as:

- Indicator: A species that was **only listed for the focal bushland** type among all the bushland types described for the same floristic region of the focal bushland type. For example, *Acacia bussei* is an indicator for Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket since this species was only listed for Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket (White 1983 p. 114) among all the bushland and thickets described for the Somali-Masai floristic region.
- Characteristic species: A species that was listed for more than one of the bushland types that were described for the same floristic region, including the focal bushland type. For example, *Grewia tembensis* is a characteristic species for Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket since it is listed for Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket (White 1983 p. 114), but is also listed for East African evergreen and semi-evergreen bushland and thicket (White 1983 p. 115).
- Species that are not characteristic: A species that was **listed** among all the bushland and thicket types described for the same floristic region as the focal bushland type, but that was **not listed** for the focal bushland type. For example, *Euphorbia candelabrum* is a negative indicator for Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket since this species was only listed for East African evergreen and semi-evergreen bushland and thicket (White 1983 p. 115) among all the bushlands described for the Somalia-Masai floristic region (and thus not listed as a species for Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket).

Information on indicators was used to identify the VECEA bushland type during the compilation of the VECEA map[2]. **For each of the national bushland or thicket types, the selected VECEA bushland type was the bushland type with the highest number of indicators (for this analysis, the complete species assemblages were investigated [*i.e.* not only the subset of species shown in the species composition tables in the 'sections 3']).**

We did not compile lists of indicators for bushland and thicket types that we deem are easy to be recognized and classified in the field: riverine thicket (br), the montane Ericaceous belt (E), *Termitaria* vegetation (T), and Zambezian rupicolous bushland and thicket. We thought that it was not necessary for these types to re-confirm the regional classification based on indicator species.

2: One national bushland vegetation type was not reclassified as one of the regional bushland types. This vegetation type was *Commiphora - Euphorbia - Lannea* bushland (originally coded in Uganda as mapping unit T5). In Langdale-Brown et al. (1964, p. 65), it was mentioned that this vegetation type was secondary to mapping unit R1 ("*Acacia t*ree and shrub steppe", mapped in VECEA as deciduous bushland and thicket [Bd]), whereas in Langdale-Brown *et al.* (1964 p. 68) information was given that the vegetation type was "appearing to be a natural climax". For the additional reasons that this vegetation type only occurred in small polygons and always in mosaic with other vegetation types, we did not include it in the VECEA map.

2.4. Information on the distribution of altitude, rainfall and temperature for each bushland and thicket type

We obtained information on annual rainfall and annual mean temperature from Worldclim (Hijmans *et al.* 2005; resolution of 30 arc seconds [~ 925 m]). Information on altitude was obtained from CGIAR-CSI (2008; resolution of 3 arc seconds [~ 90 m]). We created a layer of sample points at a density of approximately one point per 5 km^2 and with a minimum distance of 900 m. In a next step, we sampled the environmental data layers at the sample point locations. All steps were carried out in the GRASS GIS software (GRASS Development Team 2010).

For histograms, we excluded sample points from vegetation mosaics (*i.e.* polygons that contained more than one vegetation type). In each histogram, we compare the distribution of altitude, temperature and rainfall of the focal bushland type with the distributions for all vegetation types and for all bushland types combined. The information for the combined vegetation types was also based on exclusion of sample points from vegetation mosaics.

3. Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket (Bd)

3.1. Description

Within volumes 2 to 5, we use the synonym of "deciduous bushland (Bd)" as a synonym of "Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket (Bd)".

Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket is the climax vegetation type over the greater part of the Somalia-Masai floristic region. It characteristically is a dense bushland of 3 to 5 m tall with scattered emergent trees up to 9 m. Emergent species are only a few species that have well-defined trunks which carry the crown well above the main canopy; they are virtually absent from the driest areas. Most of the characteristic species of the main canopy are multiple-stemmed bushes or small bushy trees that are branched near the base. In higher rainfall areas (especially on rocky hills), the emergent trees occur closer together and are somewhat larger (but only exceptionally taller than 10 m). Some authors have categorized this physiognomic variant as woodland. Locally thickets are formed that are impenetrable. Even when canopy cover is less than 40 percent, but where grasses are inconspicuous (such as the ephemeral species of *Aristida adscensionis*, *Aristida congesta, Brachiaria eruciformis and Brachiaria leersioides* and the short-lived perennial species of *Cenchrus ciliaris*, *Chloris roxburghiana* and *Schmidtia pappophoroides*) and most of the phytomass consists of bushes (as in many places within deciduous bushland), it would be misleading to classify this vegetation as wooded grassland. In areas where rainfall is somewhat less than 250 mm per year (but probably more than 200 mm - see Somalia-Masai semi-desert grassland and shrubland [S]), the vegetation of 2 to 3 m high bushes and stunted trees (principally of *Acacia reficiens* ssp. *misera*) is intermediate between bushland and shrubland (White 1983 pp. 113 - 114).

There is appreciable variation in floristic composition, but species of *Acacia*, *Commiphora*, *Grewia* and various Capparidaceae species [*e.g. Boscia, Cadaba* and *Maerua*] [(3)] are nearly always present. The dominant *Acacia* species and some of the *Commiphora* species are spinous. Some *Commiphora* species and *Terminalia orbicularis* have several massive branches that radiate from a common base. Most species are deciduous (loosing their leaves simultaneously and usually for several weeks or months [White 1983 p. 46]). Evergreen species occur throughout, but never contribute more than 10 percent of phytomass (White 1983 p. 113).

White (1983 p. 48) describes the African pattern that where annual rainfall is between 250 and 500 mm and where there are two rainy seasons, deciduous bushland and thicket communities of regional extent (such as Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket) occur. Where annual rainfall is also between 250 and 500 mm, but falls entirely in the summer -

3: Lind and Morrison (1974 p. 60) mention that members of the Capparidaceae family are common and include species of *Boscia, Cadaba* and *Maerua*. These are sometimes spiny and can be recognized by their showy flowers with many stamens and succulent, berry-like fruits on long stalks. These authors also refer to *Grewia* species that are commonly found and are often in flower (most have yellow or white flowers with many stamens, but the common *Grewia similis* has bright mauve flowers).

as in the Sahel and Kalahari-Highveld floristic transition zones, grasses are favoured on sandy soils and the most widespread vegetation type becomes wooded grassland.

White (1983 p. 114) describes deciduous bushland that occurs in Tsavo National Park (between Garissa and Voi in Kenya) as typical. Most of the species that White (1983) listed as characteristic were indicator species (see also section 3.2). Only four species (including three climbers) were also listed as characteristic species for evergreen bushland (Be): *Cissus quadrangularis* and *Cissus rotundifolia* (climbers listed for this vegetation type occurring in the Lake Victoria region), *Grewia tembensis* (listed as a smaller bush and shrub for deciduous bushland and as a large bush in East African evergreen bushland) and *Sarcostemma viminale* (a climber listed for this vegetation type occurring in East Africa).

The indicator species can be further categorized in: (i) characteristic species of the main canopy; (ii) emergent species; (iii) smaller bushes and shrubs; (iv) succulents; and (v) climbers.

- Characteristic species of the main canopy include[4]: ***Acacia bussei, Acacia mellifera*** (also scattered in Somalia-Masai edaphic grassland), ***Acacia nilotica, Acacia reficiens, Acacia thomasii, Balanites rotundifolia, Boscia coriacea*** (evergreen, often one of the few species that are not eliminated by elephants in severely degraded bushland), ***Boswellia neglecta, Cadaba farinosa, Cadaba heterotricha, Cassia abbreviata, Commiphora africana, Commiphora campestris, Commiphora edulis, Commiphora erythraea, Commiphora mollis, Commiphora schimperi*** (also scattered in Somalia-Masai edaphic grassland), ***Cordia monoica, Cordia sinensis, Dobera glabra, Dobera loranthifolia*** (evergreen), ***Euphorbia scheffleri, Givotia gosai, Hymenodictyon parvifolium, Lannea alata, Lannea triphylla, Platycelyphium voense, Premna hildebrandtii, Salvadora persica*** (evergreen), ***Sesamothamnus rivae, Sterculia africana, Sterculia rhynchocarpa, Sterculia stenocarpa, Terminalia orbicularis, Terminalia parvula*** and ***Thylachium thomasii***.
- Emergent species include ***Acacia tortilis*** (also scattered in Somalia-Masai edaphic grassland), ***Adansonia digitata*** (often only 8 m tall with a short but massive trunk), ***Delonix elata, Euphorbia robecchii*** (a candelabra-like succulent), ***Melia volkensii*** (this species persists longer than most woody species in degraded bushland) and ***Terminalia spinosa.***
- Smaller bushes and shrubs include ***Bauhinia taitensis, Bridelia taitensis, Caesalpinia trothae, Carphalea glaucescens, Caucanthus albidus, Combretum aculeatum, Ecbolium amplexicaule, Erythrochlamys spectabilis, Grewia fallax, Grewia tembensis, Grewia tenax, Grewia villosa, Maerua deinhardtiorum, Premna resinosa, Sericocomopsis hildebrandtii*** and ***Sericocomopsis pallida***.
- Succulents include ***Adenium obesum, Calyptrotheca somalensis, Calyptrotheca taitensis, Euphorbia grandicornis, Eu-***

4: White (1983 p. 114) did not list *Acacia senegal* among the characteristic species of the main canopy. However, this is probably an oversight since *Acacia senegal* is listed as one of the dominant species of deciduous bushland in Marsabit district (White 1983 p. 121). *Acacia senegal* var. *kerensis* is a typical constituent of deciduous bushland and the main producer of gum arabic in Kenya. The variety of *Acacia senegal* var. *senegal* is a typical variety of biotic *Acacia* wooded grassland (We; F. Gachathi, pers. comm.).

phorbia nyikae (a candelabra-like succulent that is more restricted than *Euphorbia robechii*), ***Euphorbia robecchii*** (a candelabra-like succulent that also is an emergent), ***Euphorbia quinquecostata*** (a candelabra-like succulent that is more restricted than *Euphorbia robechii*) and ***Monadenium invenustum***.

- Climbers include ***Adenia globosa*** (a climber with enormous half-submerged water storing tubers), ***Gerrardanthus lobatus, Kedrostis gijef, Pergularia daemia, Pyrenacantha malvifolia*** (a climber with enormous half-submerged water storing tubers, often one of the few remaining species in severely degraded bushland) and ***Thunbergia guerkeana***.

Figure 3.1 *Acacia-Commiphora* deciduous bushland 57 km from Konso on route to Yabello (Ethiopia). Photograph by Sebsebe Demissew (May 2008).

Figure 3.2 *Acacia-Commiphora* bushland on fine-grained reddish sand. The photograph was taken near Yabelo (Ethiopia) after a rainy season with above-average rainfall. Altitude approximately 1600 metres. Photograph by I. Friis and Sebsebe Demissew (November 1997). Reproduced from Biologiske Skrifter of the Royal Danish Academy of Sciences and letters, Vol. 58, Fig 15B. 2010.

Figure 3.3 Partly exposed tubers of *Pyrenacantha malviifolia* in the underground of *Acacia-Commiphora* deciduous bushland (Bd), here partly on black cotton soil (vertisol). Near Sof Omar (Ethiopia). Altitude approximately 1500 metres. White (1983 p. 114) described this species as a climber with enormous half-submerged water storing tubers and often one of the few remaining species in severely degraded Somalia-Masai *Acacia-Commiphora* deciduous bushland. Photograph by I. Friis and Sebsebe Demissew (October 1984). Reproduced from Biologiske Skrifter of the Royal Danish Academy of Sciences and letters, Vol. 58, Fig 15H. 2010.

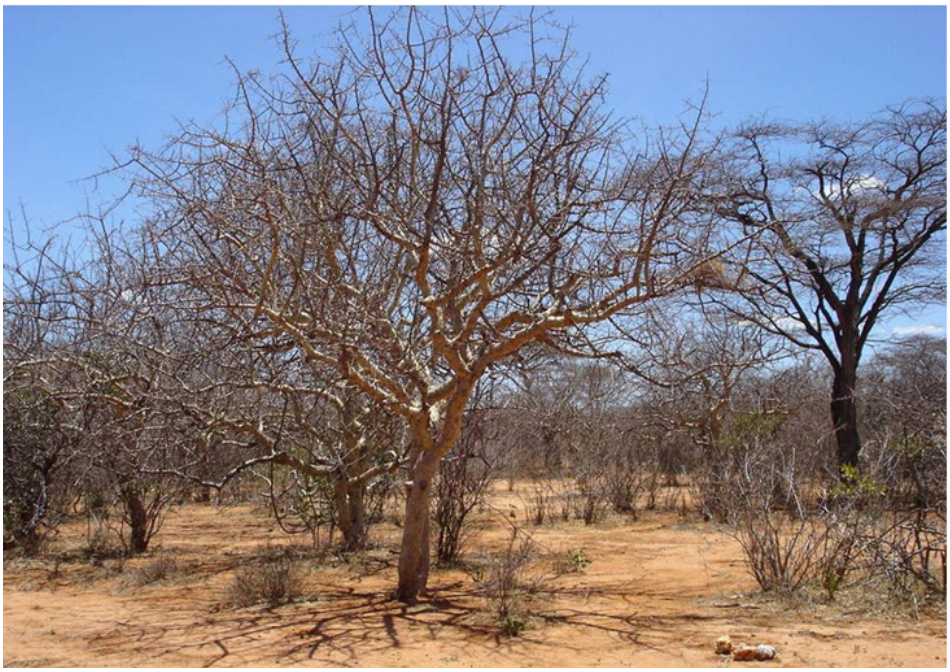


Figure 3.4 *Acacia-Commiphora* deciduous bushland in Garbatula (Kenya). The species in the foreground is *Commiphora holtziana*. The emergent tree at the right is *Acacia tortilis*. Photograph by F. Gachathi (2011).

Figure 3.5 *Commiphora africana* is a typical species of *Acacia-Commiphora* deciduous bushland. The image above shows the species during the dry season (Garbatula, Kenya, photograph taken in 2011), whereas the image below shows the species during the wet season (Samburu district, Kenya, photograph taken in 2009). Photographs by F. Gachathi.

Figure 3.6 *Commiphora holtziana* produces opoponax (hagar). This species can dominate large sections of *Acacia-Commiphora* bushland in Kenya as in Garbatula shown here. Photograph by F. Gachathi (2011).

Figure 3.7 *Acacia senegal* var. *kerensis* is a typical constituent of *Acacia-Commiphora* deciduous bushland and thicket, as in the thicket shown here from Isiolo District (Kenya). This species is the main producer of gum arabic in Kenya. Another variety of this species, *Acacia senegal* var. *kerensis*, is typical of biotic Acacia wooded grassland (We, see Volume 3). Photograph by F. Gachathi (2008).

Figure 3.8 *Acacia reficiens* ssp. *misera* can form almost uniform stands as shown here in Garbatula (Kenya).

Figure 3.9 White (1983 p. 114) describes that *Acacia reficiens* ssp. *misera* is the typical stunted tree species of vegetation that is intermediate between bushland and shrubland (in VECEA, this vegetation type was mapped as the "stunted bushland" subtype of Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket [Bds]). Photographs taken by F. Gachathi (2011).

3.2. VECEA region

Within the VECEA region, Somalia-Masai *Acacia-Commiphora* bushland and thicket occurs in Ethiopia, Kenya, Tanzania and Uganda (see Figures 3.10 and Volume 6). For Kenya, we mapped a subtype of stunted bushland separately (Figure 3.11). We do not expect that this vegetation type exists in Malawi, Rwanda and Zambia.

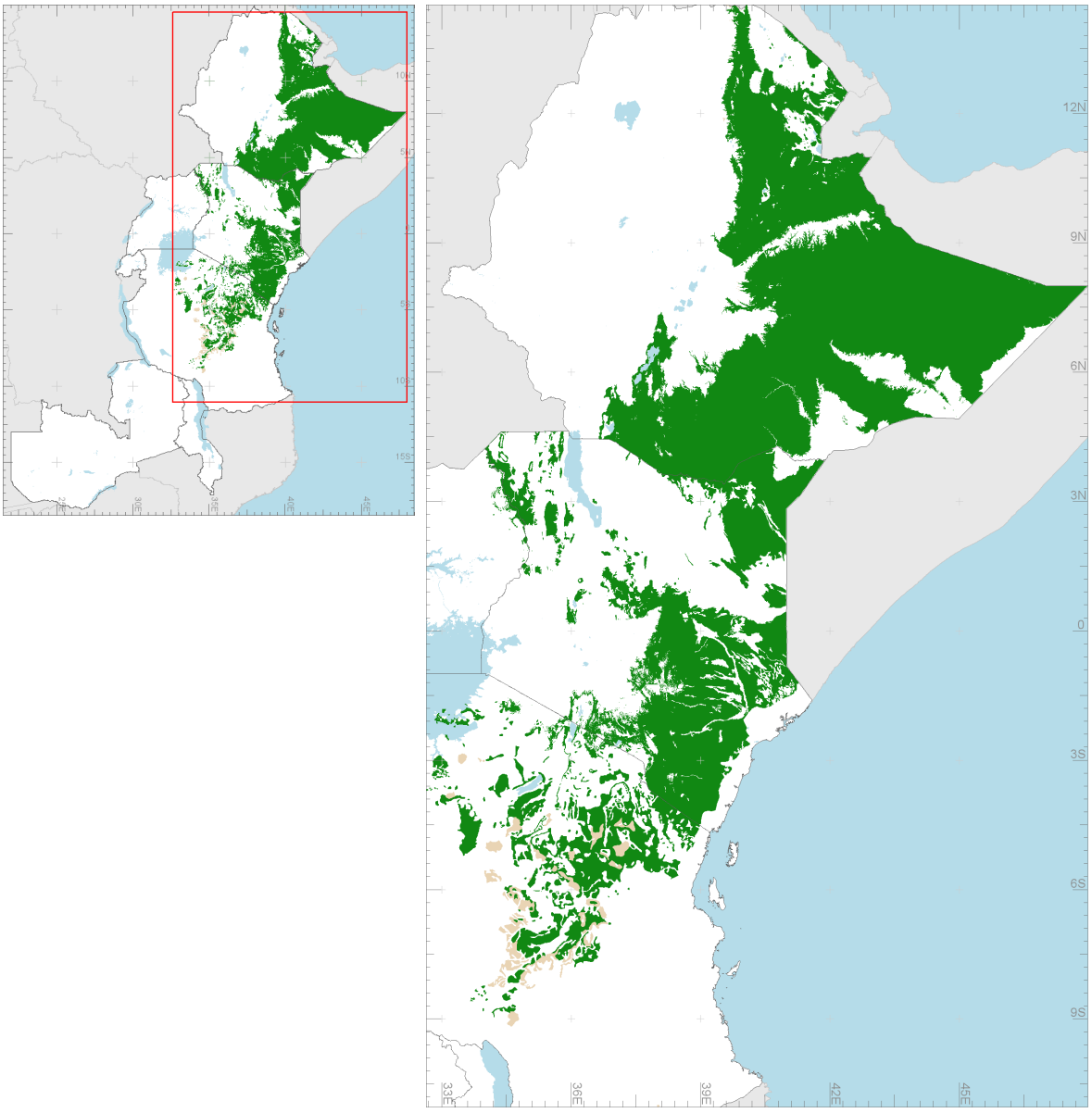


Figure 3.10. Mapped distribution of Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket in the VECEA region (Ethiopia, Kenya, Malawi, Rwanda, Tanzania, Uganda and Zambia). Where this vegetation type does not occur in mosaic, it is depicted by green polygons. Where this vegetation type occurs as part of different vegetation mosaics (as in Tanzania), this vegetation is mapped as greyish-brown polygons. The Kenyan stunted bushland subtype was excluded (see Figure 3.11; note that stunted bushland possibly also occurs within the areas depicted in the figure directly below).

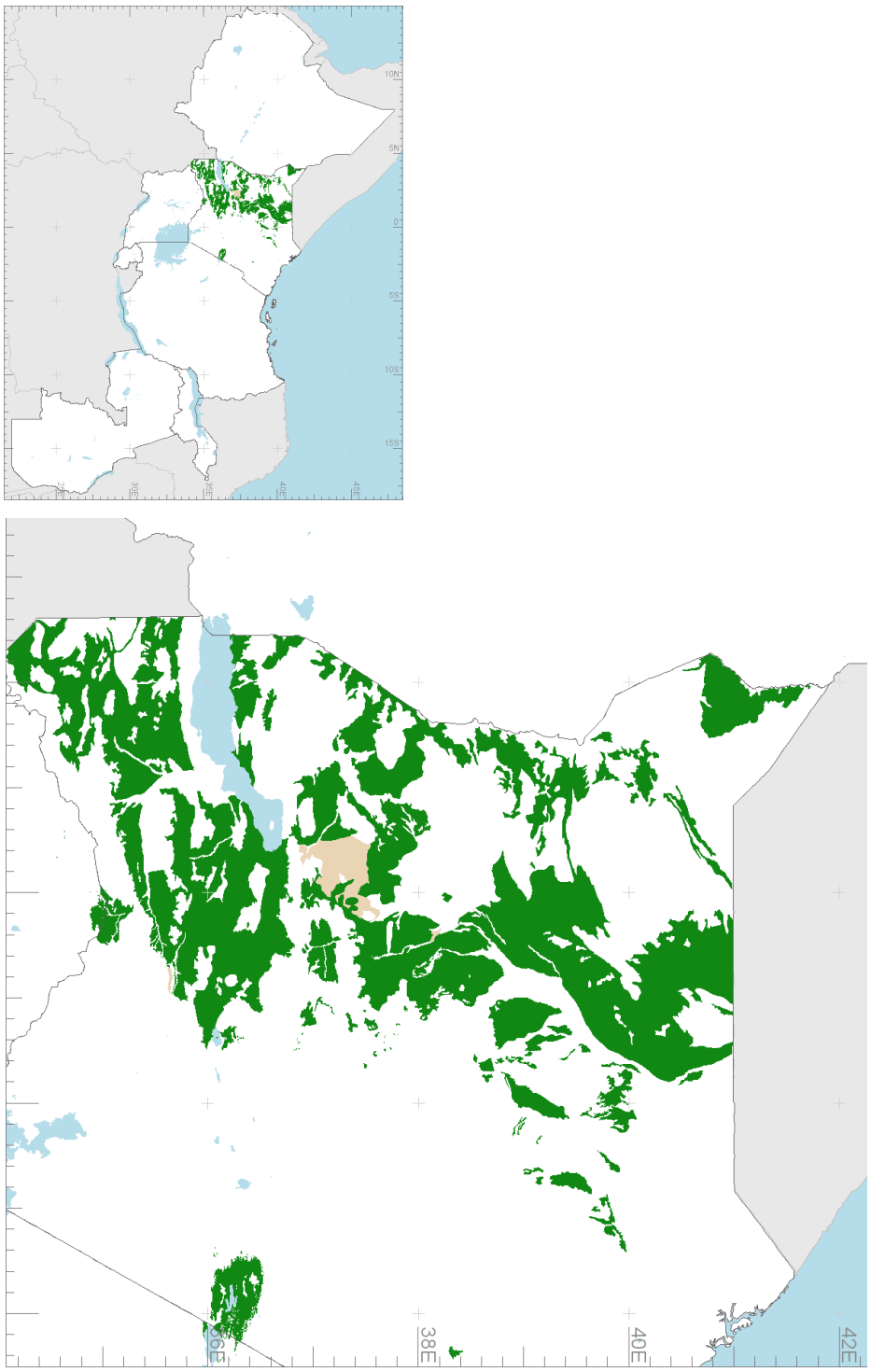


Figure 3.11. Mapped distribution of the "stunted bushland" subtype of Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket in the VECEA region (Ethiopia, Kenya, Malawi, Rwanda, Tanzania, Uganda and Zambia). This stunted subtype was only mapped in Kenya, but possibly also occurs in other countries where Somalia-Masai *Acacia-Commiphora* bushland and thicket is present. Where this vegetation type does not occur in mosaic, it is depicted by green polygons. This vegetation is also mapped as part of different vegetation mosaics (shown in greyish-brown); these polygons depict areas in Marsabit District where "stunted bushland" occurs in mosaics of semi-desert vegetation (S, see Volume 4).

In Ethiopia, Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket was originally classified and mapped as "*Acacia-Commiphora* woodland and bushland proper" [original mapping unit ACB).

The Range Management Handbook of Kenya (RMHK) contained mapping units 14 (deciduous bushland), 15 (deciduous bush [perennial] grassland), 16 (deciduous bush annual grassland), 20 (deciduous shrubland), 21 (deciduous shrub [perennial] grassland) and 22 (deciduous shrub annual grassland). We classified the "shrubland" of the RMHK as "stunted bushland" in VECEA based on the comment of White (1983 p. 120) that "stunted deciduous bushland (…) is intermediate between bushland and shrubland (…) **and is referred to by Herlocker as shrubland**" (Herlocker was the main botanist for the RMHK). However, the physiognomic difference between "bush ([annual] grasslands)" and "shrub ([annual] grasslands" as defined in the RMHK is that trees [5] form less than 10% of the overall tree crown cover in "shrubland" (RMHK Volume II.1).

We did not have sufficient details on the physiognomic differences between "woodland", "bushland" and "thicket" subtypes of " *Acacia-Commiphora* low woodland, thicket and bushland" of the Trapnell *et al.* (1966, 1969, 1976, 1986; see also Trapnell and Brunt [1987]) vegetation sheets for central and south-western Kenya. As we assumed that the "woodland" classification did not involve substantially taller vegetation than typical of bushland and since typical wooded grassland would have been classified as "savanna", we classified all " *Acacia-Commiphora* low woodland, thicket and bushland" as Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket (Bd), including *Acacia tortilis* woodland on alluvium (original mapping unit 21b, sheets 1, 2 and 4) and *Commiphora* thicket and woodland (original mapping unit 20b, sheets 2 and 4).

In Tanzania, Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket was mapped by including all bushland areas from the Tanzanian section of the Somalia-Masai floristic region (see Volume 6).

For Uganda, Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket was mapped by including areas that were nationally as subtypes of " *Acacia-Commiphora* bushland", " *Acacia* or Lannea- *Acacia* tree and shrub steppe" [6] and "*Acacia nubica* thicket" (see section 3.3 and Volume 6). Langdale-Brown *et al.* (1964 p. 65) mention that overgrazing has resulted in widespread succession of "tree and shrub steppe" (original mapping unit R) to bushland and thicket [7]. Although Langdale-Brown *et al.* (1964 p. 66) indicate that most bushland communities are probably regressional stages, there are clear floristic similarities with the climax Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket communities described for other countries (see section 3.2).

Investigation of environmental distribution of Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket in the VECEA region (Figure 3.12; limits are for areas of the VECEA map where this vegetation type is not mapped as mosaic) shows that more than 90% of the samples occur in

5: "Trees" are distinctly differentiated into trunk and crown, "shrubs" are less than 6 m in height and "dwarf shrubs" are smaller than 70 cm (RMHK)

6: Langdale-Brown *et al.* (1964 p. 21) define "savanna" as formations of grasses that are at least 80 cm high and that form a continuous layer dominating a lower stratum. This vegetation type is usually burnt annually. Woody plants are usually present. "Steppe" is defined as open herbaceous vegetation where perennial grasses are usually less than 80 cm high and widely spaced. This vegetation type is usually not burnt. Annual plants are very often abundant between the perennials. Woody plants sometimes occur.

7: As our main aim was to create a potential natural vegetation map, we followed the suggestions given by Langdale-Brown *et al.* (1964) about successional relationships between the many vegetation subtypes that they discriminated. However, in some situations information about successional pathways was not clear, for example:

- On page 65, it is mentioned that overgrazing of *Acacia* tree and shrub steppe (R1) stimulates a sequence of changes that culminates in the formation of T3 and **T5** *Acacia* and *Commiphora* bushland
- On page 68, it is mentioned that **T5** (*Commiphora - Euphorbia - Lannea*) is probably a natural climax.

an interval from 0 – 1500 m. More than 95% of samples receive between 200 and 1000 mm annual rainfall. This is a considerably wider range than provided by White (1983, 250 – 500 mm). The rainfall interval of 200 – 400 mm contains the highest number of samples (39.1%) for this vegetation type, however. The distribution of environmental conditions of Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket strongly resembles the distribution of all bushlands and thickets combined: this is a consequence of 90.8% of bushland and thickets belonging to this vegetation type. Given the wider range in annual rainfall than reported by White (1983 p. 48), it is possible that some areas that are mapped as deciduous bushland (Bd) by VECEA are in reality evergreen Bushland (Be; White [1983] gives a rainfall interval of 500 to 1000 mm for this vegetation type).

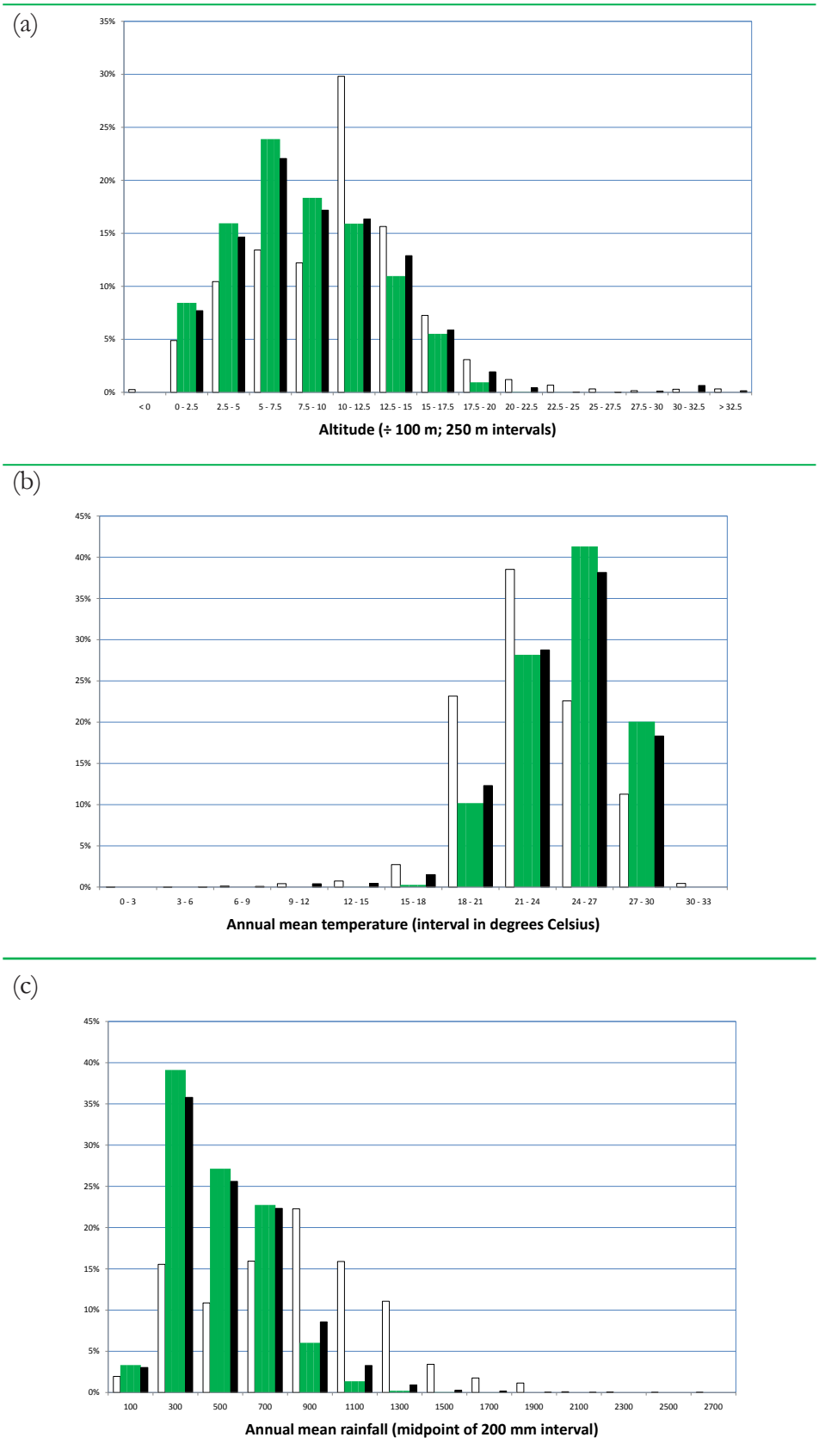


Figure 3.12. Histograms of the distribution of altitude (a), mean annual temperature (b) and mean annual rainfall (c). Bars at the centre of each interval show the percentage of samples within Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket (Bd, *n* = 228,661). Bars on left (open) show the overall percentage of samples (*n* = 740,047). Bars on the right (black) show the percentages of samples within bushlands or thickets (including all vegetation types that are described in this volume, *n* =250,418).

3.3. Species composition

Species assemblages were obtained from the following references:

- Ethiopia: Friis *et al.* 2010. Species mentioned in Appendix 3 for " *Acacia-Commiphora* woodland and bushland proper" [ACB] were coded "x" (unless they were characteristic species).
- Kenya (columns "BdK" and "BdsK"): Species that were expected to occur in the bushland type based on information from Beentje (1994), the Flora of Tropical East Africa and field experience from our Kenyan co-author (F. Gachathi) were coded "x" in column "BdK". A suffix of "a" refers to species that were recorded for mapping unit 16 of the Range Management Handbook of Kenya (RMHK, this vegetation type contains annual grasses). A suffix of "b" referred to mapping unit 14 of the RMHK. A suffix of "p" referred to species that were recorded for mapping unit 15 of the Range Management Handbook of Kenya (this vegetation type contains perennial grasses). In a separate column ("BdsK", indicating the stunted bushland subtype), species listed for mapping unit 20 of the RMHK were coded "x". Suffixes of "a" referred to mapping unit 22 (with annual grasses) and "p" referred to mapping unit 21 (with perennial grasses).
- Tanzania: White (1983 p. 128). Species that were listed as *Acacia-Commiphora* deciduous bushland and thicket in the Serengeti ecosystem were coded "x".
- Uganda (columns "BdU", "BdtU" and "BdsU"): Langdale-Brown *et al.* (1964). In column "BdU", all species mentioned in the appendix to occur in *Acacia - Lannea* bushland (original mapping unit T1) were coded "x1", those occurring in " *Acacia – Commiphora - Lannea* bushland" (T2) were coded "x2", those occurring in " *Acacia - Commiphora* bushland" (T3) were coded "x3", those occurring in "*Acacia reficiens - Commiphora* bushland and thicket" (T4) were coded "x4", those occurring in "*Commiphora - Euphorbia - Lannea* " (T5) were coded "x5", those occurring in "*Lannea - Acacia - Balanites* bushland" (T6) were coded "x6", those occurring in " *Acacia - Albizia - Dichrostachys* bushland" (T7) were coded "x7", those occurring in "*Acacia mellifera* bushland" (T8) were coded "x8" and those occurring in " *Acacia seyal -Acacia nilotica - Pennisetum mezianum* bushland " (T9) were coded "x9". In a separate column ("BdvU"), all species occurring in " *Acacia - Euphorbia* thicket" (V2) were coded "x2", all species occurring in " *Acacia - Commiphora* thicket" (V3) were coded "x3", all species occurring in "*Acacia nubica* thicket" (V4) were coded "x4" and all species occurring in "*Acacia mellifera* thicket" (V5) were coded "x5". In a third separate column ("BdrU"), all species that were listed to occur in "*Acacia* tree and shrub steppe" (R1) in the appendix were coded "x1" (unless they were characteristic species) and all species that were listed to occur in "*Lannea - Acacia* tree and shrub steppe" (R2) in the appendix were coded "x2" (unless they were characteristic species).

Characteristic species were determined as:

- Ethiopia: Those species that were mentioned in the description of the vegetation type in the main text were coded as "C".
- Kenya: characteristic species were not identified.
- Tanzania: Characteristic species were not identified.
- Uganda: species that were mentioned in the main reference text were coded "C".

Within the information on assemblages, coding "f" indicates that there is information that the species **potentially** occurs in the vegetation type since it occurs in the focal country and in the same bushland type in other countries (see section 2.3).

Table 3. Species composition table for Somalia-Masai *Acacia-Commiphora* deciduous bushland and thicket (Bd)

Species	Regional status (see section 2.3)	(Ethiopia)	BdK (Kenya)	BdsK (Kenya subtype)	(Tanzania)	(Uganda)	BdvU (Uganda subtype)	BdrU (Uganda subtype)
Acacia asak		x						
Acacia brevispica		x	xbp	x	f	C257 x34	C3 x2	
Acacia bussei	indicator (main canopy)	C	xbp	x	f		C5	
Acacia drepanolobium	not characteristic (edaphic grassland and biotic Acacia wooded grassland)	C	xp	xp	x	x89		x1
Acacia elatior			x			f		
Acacia gerrardii	not characteristic (characteristic for biotic Acacia wooded grassland)	f	x		f	x5		
Acacia hockii	not characteristic (characteristic for biotic Acacia wooded grassland)	f	x		f	C3 x25		
Acacia lahai		x	xp		f	f		
Acacia mellifera	indicator (main canopy, also scattered in seasonally waterlogged grassland within Acacia-Commiphora bushland)	x	xbp	xap	x	C1348 x9	C235 x4	C1 x2
Acacia nilotica	indicator (main canopy)	x	xbp	x	f	C189 x267	x34	x1
Acacia oerfota		x	xb	xap	f	f	C4	
Acacia paolii		x	x	xap				
Acacia polyacantha		f	x		f	f		
Acacia reficiens	indicator (main canopy)	C	xabp	xap	f	C4	C5	
Acacia senegal	not characteristic (characteristic for biotic Acacia wooded grassland; but see footnote 4)	x	xap	xap	f	C6 x7		
Acacia seyal	not characteristic (characteristic for biotic Acacia wooded grassland)	x	xap		x	C59 x2	C2 x35	C2
Acacia sieberiana		f	f		f	f		
Acacia thomasii	indicator (main canopy)		x					
Acacia tortilis	indicator (one of few species with well-defined trunk)	C	xabp	xap	x	C1 x347	C2 x345	C2
Acacia xanthophloea			x		f			
Commiphora africana	indicator (main canopy)	x	xb	x	f	C4 x3567	x3	x2
Commiphora campestris	indicator (main canopy)	C	x		f	x34	C3	
Commiphora edulis	indicator (main canopy)	C	x		f	C4 x3		
Commiphora erythraea	indicator (main canopy)	x	xab	xa				
Commiphora habessinica		x	x		x	C2 x13	x3	
Commiphora mollis	indicator (main canopy)		x		f			
Commiphora myrrha		C	x					
Commiphora rostrata		C	x					

Species	Regional status (see section 2.3)	(Ethiopia)	BdK (Kenya)	BdsK (Kenya sub-type)	(Tanzania)	(Uganda)	BdvU (Uganda subtype)	BdrU (Uganda subtype)
Commiphora schimperi	indicator (main canopy, also scattered in seasonally waterlogged grassland within *Acacia-Commiphora* bushland)	x	x		f	C5 x23		
Abutilon angulatum		x				f		
Acokanthera schimperi	not characteristic (indicator for evergreen bushland)	x	f		f	f		
Adansonia digitata	indicator (one of few species with well-defined trunk)	f	x		x			
Adenia globosa	indicator (climber with enormous water-storing tuber)	x	x		f			
Adenium obesum	indicator (succulent)	x	x			x4	x25	
Albizia amara	not characteristic (characteristic for edaphic grassland)	f	xb	x	f	C7 x2369		
Albizia anthelmintica		x	x		f	x1	x3	
Allophylus rubifolius		x	x		f	f		
Balanites aegyptiaca		C	x	x	f	C68 x157	x2345	x12
Balanites glabra		x	x		f			
Balanites rotundifolia	indicator (main canopy)	C	x	x		C68 x1	x23	
Bauhinia taitensis	indicator (smaller bush or shrub)		x					
Berchemia discolor		x	x		f	f		
Boscia angustifolia		x	x		f	x23		
Boscia coriacea	indicator (main canopy, evergreen)	x	x	x	f	f		
Boscia salicifolia		x	x		f	f		
Boswellia microphylla		C	xb	x				
Boswellia neglecta	indicator (main canopy)	C	x	C	f	x34		
Boswellia papyrifera		f	x			f		
Boswellia rivae		x	xb					
Bridelia scleroneura		f	f		f	f		
Bridelia taitensis	ndicator (smaller bush or shrub)		x					
Cadaba farinosa	indicator (main canopy)	f	x	xp	f	x189	x2345	x1
Cadaba heterotricha	indicator (main canopy)	x	x					
Caesalpinia trothae	indicator (smaller bush or shrub)	x	xb		f			
Calotropis procera		x	x	xa	f	f		
Calyptrotheca somalensis	indicator (succulent)	x	x					
Calyptrotheca taitensis	indicator (succulent)		x					

Species	Regional status (see section 2.3)	(Ethiopia)	BdK (Kenya)	BdsK (Kenya sub-type)	(Tanzania)	(Uganda)	BdvU (Uganda subtype)	BdrU (Uganda subtype)
Canthium lactescens		x	x		f	f		
Capparis tomentosa	not characteristic (indicator for evergreen bushland)	C	x		f	f		
Carissa spinarum	not characteristic (indicator for evergreen bushland)	x	x		f	f		
Carphalea glaucescens	indicator (smaller bush or shrub)	x	x		f			
Cassia abbreviata	indicator (main canopy)		x		f			
Caucanthus albidus	indicator (smaller bush or shrub)	x	x					
Cissus quadrangularis	characteristic (climber with succulent photosynthetic stems)		x		x	x4	x34	
Cissus rotundifolia	characteristic (climber with succulent leaves)	x	x		f	x2	x23	
Clerodendrum myricoides		f	x		f	f		
Combretum aculeatum	indicator (smaller bush or shrub)	C	x		f	f		
Combretum adenogonium		f	x		f	f		
Combretum collinum		f	x		f	f		
Combretum molle		f	x		f	f		
Cordeauxia edulis		x						
Cordia monoica	indicator (main canopy)	x	x		f	f		
Cordia sinensis	indicator (main canopy)	x	xabp	xap	x	f	x235	
Delonix elata	indicator (one of few species with well-defined trunk)	x	xab	xa	f	f		
Dichrostachys cinerea		x	f		f	C78 x169		
Diospyros scabra		f	x			f		
Dobera glabra	indicator (main canopy)	x	xb	xa	f	f		
Dobera loranthifolia	indicator (main canopy, evergreen)		x		f			
Dombeya kirkii		x	f		f	f		
Dombeya rotundifolia		f	x			f		
Ecbolium amplexicaule	indicator (smaller bush or shrub)		f		x			
Entada abyssinica		f	f		f	f		
Erythrina burttii			x		f			
Erythrina melanacantha		x	x		f			
Erythrochlamys spectabilis	indicator (smaller bush or shrub)	x	x					

Species	Regional status (see section 2.3)	(Ethiopia)	BdK (Kenya)	BdsK (Kenya sub-type)	(Tanzania)	(Uganda)	BdvU (Uganda subtype)	BdrU (Uganda subtype)
Euclea divinorum	not characteristic (indicator for evergreen bushland)	x	x		f	f		
Euclea racemosa		f	xp		f	f		
Euphorbia candelabrum	not characteristic (indicator for evergreen bushland)	x	x		x	C5 x29	C3 x2	
Euphorbia grandicornis	indicator (succulent)		xb			x4	x2	
Euphorbia nyikae	indicator (succulent, candelabra euphorbia more restricted than *Euphorbia robecchii)*		x		x			
Euphorbia quinquecostata	indicator (succulent, candelabra euphorbia more restricted than *Euphorbia robecchii*)		x		f			
Euphorbia robecchii	indicator (one of few species with well-defined trunk, *candelabra euphorbia*	x	x		f			
Euphorbia scheffleri	indicator (main canopy)	x	x		f			
Euphorbia tirucalli		x	x		x	f		
Faidherbia albida		x	x		f	f		
Ficus glumosa		x	f		f	f		
Flacourtia indica		x	f		f	f		
Flueggea virosa		x	f		f	f		
Gardenia ternifolia		f	f		f	f		
Gardenia volkensii		x	xb		f	f		
Gerrardanthus lobatus	indicator (climber)		x		f	f		
Givotia gosai	indicator (main canopy)	x	x					
Grewia bicolor	not characteristic (indicator for evergreen bushland)	x	x		f	f	x3	
Grewia fallax	indicator (smaller bush or shrub)		x		f	f		
Grewia mollis		f	x		f	f		
Grewia similis	not characteristic (indicator for evergreen bushland)	f	x		f	x2	C3	
Grewia tembensis	characteristic (smaller bush or shrub)	x	xab	xa				
Grewia tenax	indicator (smaller bush or shrub)	x	xab	xap	f	x4	C3 x5	
Grewia villosa	indicator (smaller bush or shrub)	x	xb	xp	f	x378	x235	
Harrisonia abyssinica		x	x		f	f		
Hymenodictyon parvifolium	indicator (main canopy)		x		f	f		
Hyphaene compressa	(palm species)	x	x	xa	f			
Hyphaene thebaica	(palm species)	x	f	xa				
Jatropha curcas			x		f	f		

Species	Regional status (see section 2.3)	(Ethiopia)	BdK (Kenya)	BdsK (Kenya sub-type)	(Tanzania)	(Uganda)	BdvU (Uganda subtype)	BdrU (Uganda subtype)
Kedrostis gijef	indicator (climber)		x		f			
Lannea alata	indicator (main canopy)		x		f			
Lannea humilis	not characteristic (characteristic for edaphic grassland)	x	f		f	C6 x157	C3 x24	C2
Lannea rivae		x	x		f			
Lannea schimperi		f	f		f	f		
Lannea schweinfurthii		f	x		f	f		
Lannea triphylla	indicator (main canopy)	x	x		f	C5 x1237	C3	C2
Lawsonia inermis		x	xb	x	f	f		
Leptadenia hastata		x	f					
Maerua decumbens		x	x		f	f		
Maerua deinhardtiorum	indicator (smaller bush or shrub)	x	x					
Manilkara mochisia			x		f			
Manilkara sulcata			x		f			
Maytenus senegalensis		x	x		f	f		
Melia volkensii	indicator (one of few species with well-defined trunk)	x	x		f			
Meyna tetraphylla		f	x		f	f		
Monadenium invenustum	indicator (succulent)		f					
Moringa oleifera			x		f	f		
Moringa stenopetala		f	x					
Newtonia hildebrandtii			x		f			
Oncoba spinosa		f	x		f	f		
Opilia campestris		x	x		f			
Ormocarpum kirkii			x		f			
Ormocarpum trachycarpum		x	x		f	f		
Ormocarpum trichocarpum		x	x		f	x1		
Otostegia integrifolia		x						
Ozoroa insignis		x	f		f	x7		
Parkinsonia aculeata			x					

Species	Regional status (see section 2.3)	(Ethiopia)	BdK (Kenya)	BdsK (Kenya sub-type)	(Tanzania)	(Uganda)	BdvU (Uganda subtype)	BdrU (Uganda subtype)
Pavetta crassipes		x	f		f	f		
Pergularia daemia	indicator (climber)	x			f			
Phoenix dactylifera	(palm species)		x		f			
Phoenix reclinata	(palm species)	f	x		f	f		
Platycelyphium voense	indicator (main canopy)	x	x		f			
Plectranthus barbatus		x	f		f	C5 x2	C23	
Populus ilicifolia			x		f			
Premna hildebrandtii	indicator (main canopy)		x		f			
Premna resinosa	indicator (smaller bush or shrub)	x	x		f	f		
Psydrax schimperiana		x	x		f	f		
Pterolobium stellatum	not characteristic (indicator for evergreen bushland)	x	f		f	f		
Pyrenacantha malvifolia	indicator (climber with enormous water-storing tuber)	x	x		f			
Rhoicissus revoilii		x	f		f	f		
Rhoicissus tridentata		x	f		f	f		
Rhus natalensis	not characteristic (indicator for evergreen bushland)	x	x	x	f	x2	x3	
Rhus tenuinervis		x	f		f			
Rhus vulgaris		x	f		f	f		
Saba comorensis		x	f					
Salvadora persica	indicator (main canopy, evergreen)	x	xap	xap	x	f		
Sarcostemma viminale	characteristic (climber with succulent photosynthetic stems)	x	f			x4	x3	
Sclerocarya birrea	not characteristic (characteristic for edaphic grassland)	f	x		f	C3 x2		
Searsia retinorrhoea		x						
Senecio hadiensis		x	f		f	f		
Senna alexandrina		x	x					
Senna didymobotrya		x	f		f	f		
Senna singueana		f	x		f	f		
Sericocomopsis hilde-brandtii	indicator (smaller bush or shrub)	x	xabp	xap	f	x4		

Species	Regional status (see section 2.3)	(Ethiopia)	BdK (Kenya)	BdsK (Kenya sub-type)	(Tanzania)	(Uganda)	BdvU (Uganda subtype)	BdrU (Uganda subtype)
Sericocomopsis pallida	indicator (smaller bush or shrub)	x	xb	x	f			
Sesamothamnus rivae	indicator (main canopy)	x	x		f	x4		
Spirostachys venenifera			x		f			
Steganotaenia araliacea		x	x		f	x2		
Sterculia africana	indicator (main canopy)	x	xb		f			
Sterculia rhynchocarpa	indicator (main canopy)	x	f		f	x3		
Sterculia stenocarpa	indicator (main canopy)	x	x		f	f		
Stereospermum kunthi-anum		f	x		f	f		
Tamarindus indica		x	f		f	f		
Tamarix aphylla		f	x					
Tamarix nilotica		f	x		f			
Tarenna graveolens	not characteristic (indicator for (evergreen bushland)	x	f		f	x3		
Terminalia brownii		x	f		f	C3 x7		
Terminalia orbicularis	indicator (main canopy)	C	xa					
Terminalia parvula	indicator (main canopy)		x					
Terminalia prunioides		x	x		f			
Terminalia spinosa	indicator (one of few species with well-defined trunk)	x	xb	x	f	f		
Tetradenia riparia		f	x					
Thunbergia guerkeana	indicator (climber)		x		f			
Thylachium thomasii	indicator (main canopy)		x					
Uvaria scheffleri			x		f	f		
Vangueria madagascariensis		x	f		f	f		
Woodfordia uniflora		f	x			f		
Ximenia americana		x	x		f	x5		
Zanthoxylum chalybeum		x	xb	x	f	C7	x3	
Zanthoxylum usambarense		f	x		f			
Ziziphus abyssinica		f	x		f	f		

Species	Regional status (see section 2.3)	(Ethiopia)	BdK (Kenya)	BdsK (Kenya sub-type)	(Tanzania)	(Uganda)	BdvU (Uganda subtype)	BdrU (Uganda subtype)
Ziziphus mauritiana		x	x		f	f		
Ziziphus mucronata		x	x		f	f		
Ziziphus pubescens		f	x		f	f		
Ziziphus spina-christi		x	x		f	f		

4. Evergreen and semi-evergreen bushland and thicket (synonym: evergreen bushland, Be)

4.1. Description

Within volumes 2 to 5, we use the synonym of "evergreen bushland (Be)" as a synonym of "evergreen and semi-evergreen bushland and thicket (Be)".

White (1983) describes evergreen and semi-evergreen bushland and thickets within the descriptions of two floristic regions: (i) the Somalia-Masai regional centre of endemism ('East African evergreen and semi-evergreen bushland and thicket'); and (ii) the Lake Victoria regional mosaic ('evergreen and semi-evergreen bushland and thicket and derived communities').

Evergreen and semi-evergreen bushland and thicket occurs on the drier slopes of mountains and upland areas in East Africa which rise from the lowlands from the Somalia-Masai region all the way from central Tanzania to Eritrea (and beyond). It often forms an ecotone between Afromontane forest (especially Afromontane single-dominant *Juniperus procera* forest [Fbj]) and deciduous bushland (Bd) - this pattern of occurrence can be clearly observed in northern Kenya such as at on the lower slopes of Mt. Marsabit (2º 16' N, 37º 57' E). The mean annual rainfall is mostly between 500 and 850 mm and is irregularly distributed throughout the year but with two main peaks (White 1983 pp. 48 and 115).

Evergreen bushland varies greatly in composition and richness, but certain species that are nearly always present include ***Acokanthera schimperi, Carissa spinarum, Dodonaea viscosa, Euclea divinorum, Euphorbia candelabrum, Olea europaea* ssp. *cuspidata*** (synonym: *Olea africana*), ***Tarchonanthus camphoratus*** (especially in disturbed areas), ***Vepris simplicifolia*** (synonym: *Teclea simplicifolia*) together with other species of *Acokanthera, Aloe, Euclea, Euphorbia, Sanseviera* and *Vepris*. Succulents such as ***Dracaena ellenbeckiana*** and ***Euphorbia candelabrum*** that are present in evergreen bushland are absent from Afromontane single-dominant *Juniperus procera* forest (Fbj, White 1983 p. 115).

Evergreen bushland (in mosaic with Lake Victoria *Euphorbia dawei* scrub forest [fe, see Volume 2] that is edaphically restricted to rocky slopes) probably represents the climax vegetation of large parts of the Lake Victoria region. This evergreen bushland variant is floristically similar but also floristically poorer than the vegetation type with the same name that occurs in the Somalia-Masai region. The principal bushy species include ***Allophylus africanus, Azima tetracantha, Carissa spinarum*** (also listed as characteristic in East Africa), ***Capparis fascicularis*** (listed as a characteristic climber in East Africa), ***Capparis tomentosa, Erythrococca bongensis, Grewia bicolor, Maerua triphylla, Olea europaea* ssp. *cuspidata*** (synonym: *Olea*

africana, also listed as characteristic in East Africa), ***Psydrax schimperiana, Rhus natalensis*** (also listed as characteristic in East Africa), ***Tarenna graveolens*** and ***Turraea nilotica***.

Annual rainfall is higher in places where evergreen bushland occurs in the Lake Victoria region (850 mm to 1000 mm) than those places where it occurs in the Somalia-Masai region (500 to 850 mm; White 1983 pp. 48 and 182).

Where evergreen bushland is degraded (as a result from grazing), various *Acacia* species invade and **biotic Acacia wooded grassland (We)** becomes established. This vegetation type forms an alternative steady state of potential natural vegetation to evergreen bushland (*i.e.* it is possible for both types of potential natural vegetation to become established in the areas where they are mapped separately).

The grasslands of the Loita and other plains that occur in Narok district (including parts of the Masai-Mara reserve) are similar in grass species composition as the edaphic grasslands on volcanic soils of the Serengeti plains (gv, see Volume 5). However, these grasslands in Narok district are secondary to evergreen bushland as a result from fire and browsing (White 1983 p. 127). Areas capable of supporting evergreen bushland in Nairobi National Park have been converted to grassland as a result from browsing, grazing and fire (White 1983 p. 116).

White (1983) describes relatively undisturbed evergreen bushland (locally impenetrable) that occurred near Nairobi between 1875 and 2080 m. Most of the species that White (1983) listed as characteristic were indicator species (see also section 4.3). Only two species were also listed as characteristic species for deciduous bushland (Bd): *Grewia tembensis* (listed as a smaller bush and shrub for deciduous bushland and thicket, and as a large bush in East African evergreen bushland) and *Sarcostemma viminale* (a succulent climber).

The indicator species can be further categorized in: (i) characteristic species of the main canopy; (ii) other large bushes; (iii) scattered emergents; (iv) shrubs; (v) climbers; and (vi) scattered stunted individuals that indicate the transition to Afromontane single-dominant *Juniperus procera* forest (Fbj).

- Characteristic species of the main canopy (3 to 7 m) include ***Acokanthera schimperi, Euclea divinorum, Gnidia subcordata, Olea europaea* ssp. *cuspidata*** (synonym: *Olea africana*], also listed as characteristic species for the Lake Victoria region), ***Tarchonanthus camphoratus*** (especially in disturbed areas) and ***Vepris simplicifolia***. (White (1983) did not list ***Carissa spinarum***, but this could be an omission).
- Other large bushes include ***Canthium keniense, Croton dichogamus, Dodonaea viscosa, Dombeya burgessiae, Grewia similis, Maytenus heterophylla*** and ***Rhus natalensis*** (also listed as characteristic species for the Lake Victoria region).
- ***Euphorbia candelabrum*** (a cactoid stem-succulent) occurs throughout as a scattered emergent up to 9 m tall. This species was

also listed as a characteristic species for the Lake Victoria region.

- Shrubs include ***Aspilia mossambicensis, Psiadia punctulata, Tinnea aethiopica*** and ***Turraea mombassana.***
- Climbers include ***Capparis fascicularis*** (also listed as characteristic species for the Lake Victoria region), ***Pterolobium stellatum*** and ***Scutia myrtina***.
- Scattered stunted individuals that indicate the transition to Afromontane single-dominant *Juniperus procera* forest (Fbj) appear at higher altitudes and include ***Calodendrum capense, Cussonia holstii, Drypetes gerrardii, Elaeodendron buchananii, Juniperus procera*** (evergreen bushland could be the original habitat of this species [White 1983 p. 165]) and ***Schrebera alata***.

Figure 4.1 Evergreen thicket in Queen Elizabeth National Park (Uganda). Emergent *Euphorbia candelabrum* covered by climbers can be seen in various places. Photograph by M. Namaganda (June 2008).

Figure 4.2 Evergreen and semi-evergreen bushland next to a remnant of Afromontane single-dominant *Juniperus procera* forest (Fbj). Near Arero (Ethiopia). Approximate altitude 1800m. Photograph by I. Friis and Sebsebe Demissew (September 2002). Reproduced from Biologiske Skrifter of the Royal Danish Academy of Sciences and letters, Vol. 58, Fig 23A. 2010.

Figure 4.3 Stands of *Dracaena ombet* subsp. *ombet* in *Acacia*-dominated bushland below remnants of Afromontane single-dominant *Juniperus procera* forest (Fbj). Between Wukro and Berahile (Ethiopia). Approximate altitude 1700 m. Photograph by I. Friis and Sebsebe Demissew (October 2009). Reproduced from Biologiske Skrifter of the Royal Danish Academy of Sciences and letters, Vol. 58, Fig 23B. 2010.

Figure 4.4 Regrowth of *Tarchonanthus camphoratus* in evergreen bushland in a transition zone between *Acacia-Commiphora* deciduous bushland and Afromontane single-dominant *Juniperus procera* forest (Fbj). Between Wukro and Berahile (Ethiopia). Approximate altitude 2000 m. (October 2009). Photograph by I. Friis and Sebsebe Demissew. Reproduced from Biologiske Skrifter of the Royal Danish Academy of Sciences and letters, Vol. 58, Fig 23D. 2010.

Figure 4.5 Evergreen bushland and thicket in Biharagu (Rwanda). Photograph taken by E. Munyaneza (October 2009).

Figure 4.6 Evergreen bushland was the original vegetation type of most of the Akagera National Park (Rwanda). Photograph by V. Minani (March 2007).

Figure 4.7 As a result from grazing, the original evergreen bushland of Akagera national park (Rwanda) has changed to the alternative steady state of biotic Acacia wooded grass-land (We). Climbers growing on *Euphorbia candelabrum* (right) can initiate the vegetation succession to evergreen bushland (see also Lebrun [1947] and White [1983 p. 183]; Photograph by D. König (September 1987).

Figure 4.8 Evergreen bushland in the Maasai Mara (original mapping unit 24). The photograph shows Diospyros abyssinica together with typical evergreen bushland species of *Euclea divinorum, Olea europaea* ssp. *cuspidata* (synonym: *Olea africana*). Person: C.G. Trapnell. Photography by E.C. Trump.

4.2. VECEA region

Within the VECEA region, evergreen and semi-evergreen bushland and thicket occurs in Ethiopia, Kenya, Rwanda, Tanzania and Uganda (Figure 4.8, see also Volume 6). We do not expect that this vegetation type occurs in Malawi, Zambia and the coastal areas of Kenya and Tanzania.

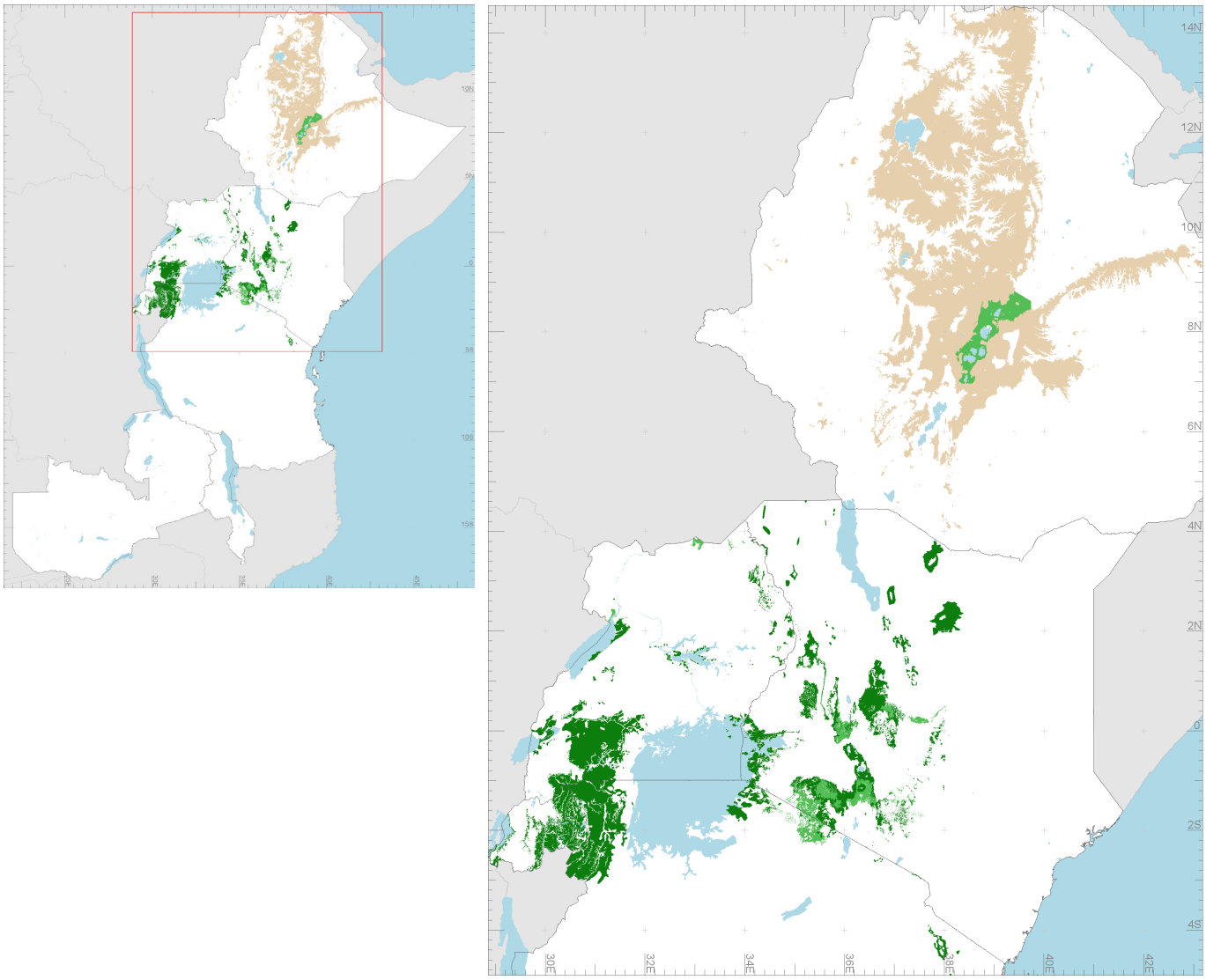


Figure 4.8. Mapped distribution of Evergreen and semi-evergreen bushland and thicket in the VECEA region (Ethiopia, Kenya, Malawi, Rwanda, Tanzania, Uganda and Zambia). Where this vegetation type is not mapped in mosaics, it is depicted by dark green polygons. This vegetation is also mapped as part of different vegetation mosaics (shown in greyish-brown). In Ethiopia, this vegetation type occurs in mosaic with Afromontane undifferentiated forest (Fbu) and Afromontane single-dominant *Juniperus procera* forest (Fbj). In Rwanda and adjacent sections in Uganda (and possibly also Tanzania), the edaphic forest type of Lake Victoria *Euphorbia dawei* scrub forest (fe) may occur is some places. Evergreen and semi-evergreen bushland and thicket is an alternative steady state of biotic *Acacia* wooded grassland (We); light-green polygons depict where we mapped this vegetation type in the VECEA region (as in Ethiopia).

In Ethiopia, evergreen and semi-evergreen bushland and thicket was originally classified as "Transition between Afromontane vegetation and *Acacia-Commiphora* bushland on the Eastern Escarpment" (original mapping unit DAF-TR). It was originally in mosaic with Afromontane undifferentiated forest (Fbu) and Afromontane single-dominant *Juniperus procera* forest (Fbj); we included this vegetation mosaic in the VECEA map.

In Kenya, evergreen and semi-evergreen bushland and thicket was originally mapped by Trapnell *et al.* (1966, 1969, 1976, 1986; see also Trapnell and Brunt [1987]) as "upland evergreen and semi-deciduous bushland types", "upland *Acacia* from evergreen and semi-deciduous bushland" and "intermediate semi-evergreen thicket and associate types". The distinction in the Kenyan Trapnell *et al.* (1966, 1969, 1976, 1986 maps between "upland evergreen and semi-deciduous bushland types" and "intermediate semi-evergreen thicket and associate types" corresponded to the phytochoristic distinction that White (1983) made between the Somalia-Masai centre of endemism and the Lake Victoria mosaic when describing evergreen bushland (with "intermediate semi-evergreen thicket and associate types" corresponding the Lake Victoria variant; see also section 4.1). The only exception to the correspondence between "intermediate semi-evergreen thickets" and the Lake Victoria region that we spotted was the occurrence of a vegetation type of "intermediate thicket, eastern type" (mapping unit 60b) on vegetation sheets 2 and 4. We have no details about this vegetation type, however.

Mapping units from the Range Management Handbook of Kenya that we reclassified as Evergreen bushland (Be) included evergreen bushland (original mapping units 10.1 and 10.2), evergreen and semi-evergreen bushland (mapping units 12.2 - 12.4; 12.1 was mapped as halophytic vegetation; 12.5 was a mosaic of evergreen bushland [Be] and deciduous bushland [Bd]), "*Acacia gerrardii - Acacia nilotica - Croton* deciduous and semi-deciduous bushland" (mapping unit 13.2), "*Euclea - Croton* evergreen shrubland" (mapping unit 17.1) and "*Croton* semi-deciduous shrubland" (mapping unit 19.1).

In Rwanda, evergreen and semi-evergreen bushland and thicket corresponds to vegetation types that were originally described as "bosquets xérophiles" and "forêt sèches". Both are defined as closed and semi-deciduous plant formations consisting of trees of intermediate height (usually less than 10 m) that occur in landscapes with wooded grasslands. "Bosquets xérophiles" occupy areas less than 1 ha, often contain spiny bushes and often occur on termite mounds on plains. "Forêt sèches" occupy areas larger than 1 ha and often occur on rocky soils or quartz (Bloesch *et al.* 2009 p. 649). White (1983 p. 182) lists Lebrun's (1955) "bosquets xérophiles à *Maerua mildbraedii* et *Carissa edulis*" and "bosquets xérophiles: association à *Jasminum fluminense* et *Carissa edulis*" as synonyms of Lake Victoria evergreen and semi-evergreen bushland and thicket.

For Uganda, we included areas that were originally mapped as the moist thicket subtype of "Undifferentiated moist semi-deciduous thicket" (original mapping unit G1) and the dry thicket subtype of "Undifferentiated deciduous thicket" (mapping unit V1).

We mapped evergreen and semi-evergreen bushland and thicket in Tanzania by applying the floristic regional boundaries that were specified for the vegetation map of Africa (White 1983; see Volume 6).

Investigation of environmental distribution of evergreen and semi-evergreen bushland and thicket bushland and thicket in the VECEA region (Figure 4.9; limits are for areas of the VECEA map where this vegetation type is not mapped as mosaic) shows that more than 90% of the samples occur in an interval from 1000 – 2250 m. The altitude interval of 1250 – 1500 m contains the highest number of samples (35.9%); this is well above the altitude interval of 500 – 750 m that contains the highest number of samples of deciduous bushland (Bd). Evergreen bushland (Be) generally receives between 400 and 1400 mm annual rainfal (> 95% of samples). This is a wider range of rainfall than provided by White (1983, 500 – 1000 mm). However, the method of using rainfall intervals with widths of 200 mm (such as the 400 – 600 mm interval) seems to have led to an exageration of the general rainfall interval for most samples: only 4.3% of samples of Evergreen bushland (Be) received less than 500 mm rainfall, which confirms the lower rainfall limit reported by White (1983). The rainfall interval of 800 – 1000 mm contains the highest number of samples (41.8%) for this vegetation type. This interval is well above the rainfall interval of 200 – 400 mm that contains the highest number of samples for deciduous bushland (Bd; 39.1%). A comparison of environmental limits of mapped deciduous bushland (Bd) and evergreen bushland (Be) in the VECEA region leads us to the conclusion that **potentially** a considerable fraction of areas that are now mapped as deciduous bushland (Bd) could be evergreen bushland (Be) in reality.

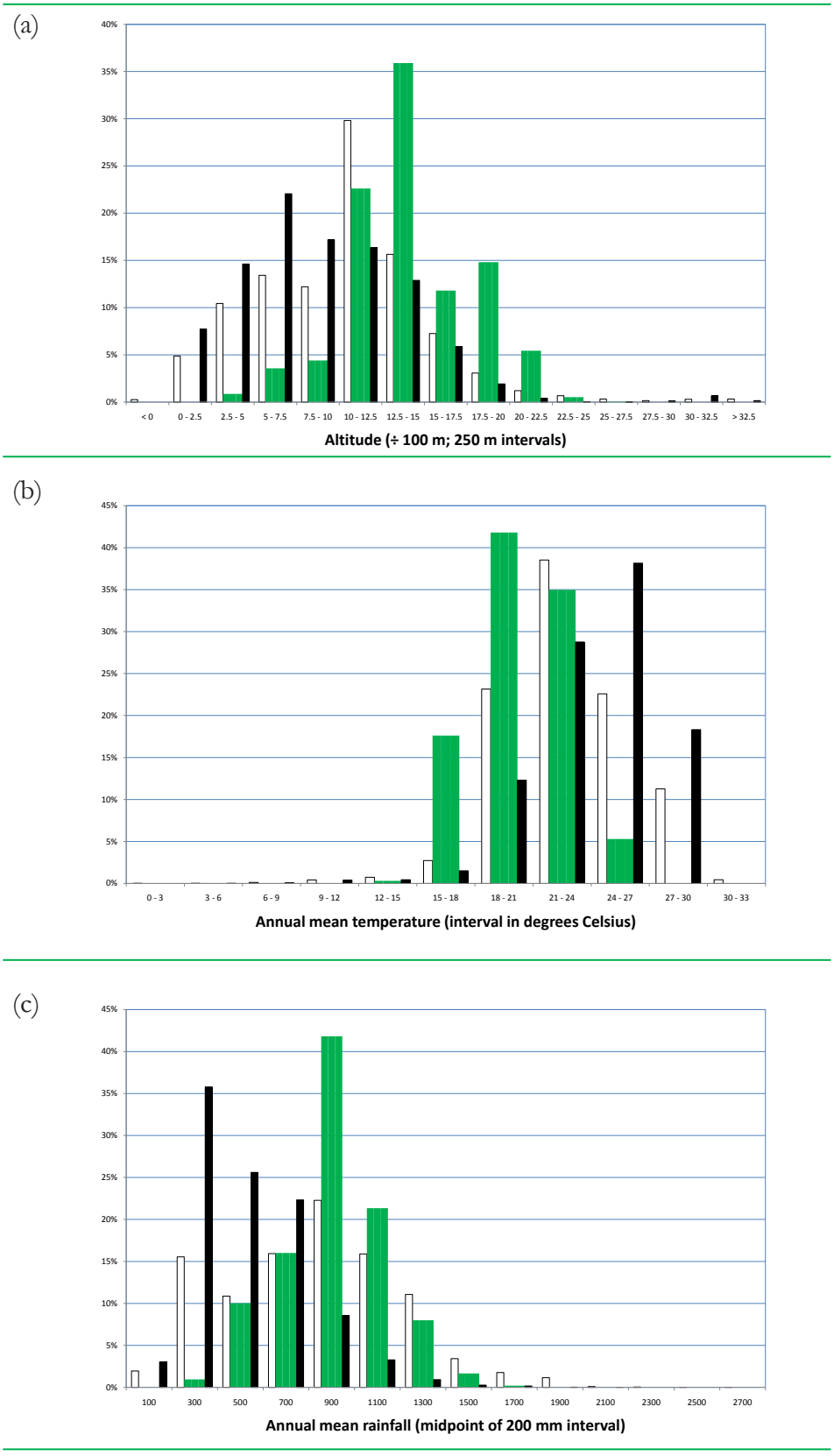


Figure 4.9. Histograms of the distribution of altitude (a), mean annual temperature (b) and mean annual rainfall (c). Bars at the centre of each interval show the percentage of samples within Evergreen and semi-evergreen bushland and thicket (Be, *n* = 17,889). Bars on left (open) show the overall percentage of samples (*n* = 740,047). Bars on the right (black) show the percentages of samples within bushlands or thickets (including all vegetation types that are described in this volume, *n* =250,418).

4.3. Species composition

Species assemblages were obtained from the following references:

- Ethiopia: Friis *et al.* 2010. Species mentioned in Appendix 3 for "Transition between Afromontane vegetation and *Acacia-Commiphora* bushland on the Eastern Escarpment" [DAF-TR] were coded "x" (unless they were characteristic species).
- Kenya (columns "BeeK" and "BewK"): Species that were expected to occur in the vegetation type based on information from Beentje (1994), the Flora of Tropical East Africa and field experience from our Kenyan co-author (F. Gachathi) were coded "x". Column "BeeK" was compiled for species expected to correspond to "East African evergreen and semi-evergreen bushland and thicket". A suffix of "n" referred to species that were recorded for mapping units of the Range Management Handbook of Kenya that we reclassified as evergreen and semi-evergreen bushland and thicket. Column "BewK" was compiled for species expected to correspond to "Lake Victoria evergreen and semi-evergreen bushland and thicket".
- Rwanda: Bloesch *et al.* (2009). Species for which information on the ecology included information on 'bosquets xérophiles' or 'forêt sèches' were coded "x". A suffix of "b" indicated that the ecology only included 'bosquets xérophiles'. A suffix of "e" indicated that the species was only listed for floristic region 1C (south eastern zone with influence from the vegetation of East Africa).
- Tanzania: White (1983 p. 129). Species that were listed for evergreen and semi-evergreen bushland and thicket in the Serengeti ecosystem or the adjacent evergreen bushland in Kenya were coded "x".
- Uganda: (columns "BemU" and "BedU") Langdale-Brown et al. (1964). All species that were listed to occur in "Undifferentiated moist semi-deciduous thicket" in the Appendix were coded "x" (unless they were characteristic species). In a separate column ("BedU"), species that were listed to occur in "Undifferentiated deciduous thicket" [V1] were also coded "x" (unless they were characteristic species).

Characteristic species were determined as:

- Ethiopia: Those species that were mentioned in the description of the vegetation type in the main text were coded as "C".
- Kenya: Species that were mentioned in names of vegetation types from central and south-western Kenya that we classified as evergreen and semi-evergreen bushland were coded "C".
- Rwanda: Characteristic species were coded "C"; these were genera or species mentioned by Lebrun (1956) or Prioul (1981).
- Tanzania: Species mentioned to be dominant near the Kenya border were coded "C".
- Uganda: Species that were mentioned in the main reference text were coded "C".

Within the information on assemblages, coding "f" indicates that there is information that the species **potentially** occurs in the vegetation type since it occurs in the focal country and in the same bushland type in other countries (see section 2.3).

Table 4. Species composition of evergreen and semi-evergreen bushland and thicket (synonym: evergreen bushland, Be)

Species	Regional status (see section 2.3)	(Ethiopia)	BeeK (Kenya subtype)	BewK (Kenya subtype)	(Rwanda)	(Tanzania)	BemU (Uganda subtype)	BedU (Uganda subtype)
Acacia abyssinica		f	x	f	f	f	f	f
Acacia brevispica		f	Cn	C	x	x	C	C
Acacia drepanolobium	characteristic (listed for biotic Acacia wooded grassland)	f	Cn	f		f	f	f
Acacia gerrardii	characteristic (listed for biotic Acacia wooded grassland)	f	Cn	x	f	x	f	x
Acacia hockii	characteristic (listed for biotic Acacia wooded grassland)	f	Cn	x	f	f	f	x
Acacia kirkii	characteristic (listed for biotic Acacia wooded grassland)		x	x	f	f	f	f
Acacia lahai		f	x	x		f	f	f
Acacia mellifera	not characteristic (indicator for(deciduous bushland)	f	Cn	f		f	f	f
Acacia nilotica	not characteristic (indicator fordeciduous bushland)	f	xn	f		f	f	x
Acacia oerfota		f	x	f		f	f	f
Acacia polyacantha		f	x	x	f	f	f	f
Acacia senegal	characteristic (listed for biotic Acacia wooded grassland)	f	xn	x	f	f	f	C
Acacia seyal	characteristic (listed for biotic Acacia wooded grassland)	f	x	C		f	f	f
Acacia tortilis	indicator (deciduous bushland)	f	xn	f		f	f	f
Acacia xanthophloea			x	f		f		
Acokanthera oppositifolia	characteristic genus		f	x				
Acokanthera schimperi	indicator (East African evergreen bushland)	C	x	x	x	f	f	f
Albizia amara	not characteristic (edaphic grassland within deciduous bushland)	f	xn	f	f	f	f	x
Albizia anthelmintica		f	x	f		f	f	f
Albizia coriaria		f	f	C		f	x	f
Albizia petersiana			f	f	x	f	f	f
Albizia zygia			f	f		f	x	x
Allophylus africanus	indicator (Lake Victoria evergreen bushland)	f	f	x	f	f	x	C
Allophylus rubifolius		f	x	x	x	f	f	f
Aloe kedongensis	indicator (East African evergreen bushland)		x					
Annona senegalensis		f	x	x	f	f	f	f
Antidesma venosum		f	f	x		f	x	f
Apodytes dimidiata		f	x	x	xe	f	f	f
Aspilia mossambicensis	indicator (East African evergreen bushland)	f	f	f		f	f	f
Azima tetracantha	indicator (Lake Victoria evergreen bushland)			x	xbe		f	f
Balanites aegyptiaca		f	x	f	f	f	f	x

Species	Regional status (see section 2.3)	(Ethiopia)	BeeK (Kenya subtype)	BewK (Kenya subtype)	(Rwanda)	(Tanzania)	BemU (Uganda subtype)	BedU (Uganda subtype)
Berberis holstii		C	f	f		f	f	f
Berchemia discolor		C	f	f		f	f	f
Bersama abyssinica		f	f	x	f	f	f	f
Boscia angustifolia		f	f	f	xb	f	f	x
Bridelia brideliifolia					f	f	x	f
Bridelia micrantha		f	x	x	f	f	f	f
Bridelia scleroneura		f	f	f		f	x	C
Cadaba farinosa	not characteristic (indicator fordeciduous bushland)	f	f	x	xb	f	f	f
Calodendrum capense	characteristic (transition to Afromontane undifferentiated forest)		x	f		f	f	f
Calotropis procera		f	x	f		f	f	f
Canthium keniense	indicator (East African evergreen bushland)		x					
Canthium lactescens		x	x	f	x	f	C	f
Capparis fascicularis	indicator (climber)	f	x	x	x	f	f	x
Capparis tomentosa	indicator (Lake Victoria evergreen bushland)	f	x	x	C	f	f	x
Carissa spinarum	indicator	f	xn	x	Cb	x	x	x
Catha edulis		C	x	f	f	f	f	f
Cissus quadrangularis	characteristic		x	x	x	f	f	
Cissus rotundifolia	characteristic	f	f	x		f	x	x
Clausena anisata		f	x	x	xb	f	f	f
Clerodendrum myricoides		x	x	x	xb	f	f	f
Combretum collinum		f	f	f	f	f	f	x
Combretum molle		f	x	f	x	f	f	f
Commiphora africana	not characteristic (indicator for deciduous bushland)	x	f	f	f	f	f	x
Cordia monoica	not characteristic (indicator for deciduous bushland)	f	x	x		x	f	f
Cordia sinensis	nnot characteristic (indicator fordeciduous bushland)	f	x	f		f	f	f
Crotalaria agatiflora		f	x	x	f	f	f	f
Croton dichogamus	indicator (East African evergreen bushland)	f	xn	x	x	x	f	
Croton macrostachyus		f	x	x	x	f	f	f
Cussonia arborea		f	x	x	xb	f	f	f
Cussonia holstii	characteristic (transition to Afromontane undifferentiated forest)	C	x	x	xb	f	f	f
Dichrostachys cinerea		f	f	x	f	f	f	x

Species	Regional status (see section 2.3)	(Ethiopia)	BeeK (Kenya subtype)	BewK (Kenya subtype)	(Rwanda)	(Tanzania)	BemU (Uganda subtype)	BedU (Uganda subtype)
Dodonaea viscosa	indicator (East African evergreen bushland)	C	xn	x	f	f	f	f
Dombeya burgessiae	indicator (East African evergreen bushland)		x	f	f	f	f	
Dombeya kirkii		f	f	f	x	f	f	f
Dombeya rotundifolia		x	x	x	f		f	f
Dovyalis abyssinica		f	x	x		f	f	f
Dovyalis macrocalyx			f	f	x	f	f	f
Dracaena ellenbeckiana	indicator (East African evergreen bushland)	C	x	f		f	f	
Drypetes gerrardii	characteristic (transition to Afromontane undifferentiated forest)		x	f	C	f	f	
Elaeodendron buchananii	characteristic (transition to Afromontane undifferentiated forest)	f	x	f	xb	x	f	f
Erythrina abyssinica		f	x	x	f	f	f	f
Erythrococca bongensis	indicator (Lake Victoria evergreen bushland)	f	f	x	x	f	f	
Euclea divinorum	indicator (East African evergreen bushland)	C	xn	x	x	x	x	f
Euclea racemosa	characteristic genus	C	xn	x	x	C	x	f
Euphorbia abyssinica		x	f	f		f	f	f
Euphorbia candelabrum	indicator (scattered emergent)	f	xn	x	f	x	x	C
Euphorbia dawei	Lake Victoria scrub forest				x	f	f	f
Euphorbia tirucalli		x	x	x	x	f	x	x
Fagaropsis angolensis		f	f	f	f	f	f	x
Faidherbia albida		f	x	f		f	f	f
Faurea rochetiana		f	x	f	x	f	f	f
Faurea saligna			x	x	f	f	f	f
Ficus glumosa		f	x	x	f	f	f	f
Flacourtia indica		f	x	x	xb	f	f	f
Flueggea virosa		f	f	f	x	f	f	f
Garcinia buchananii		f	f	f	x	f	f	f
Garcinia livingstonei		f	x	f		f	f	f
Gardenia ternifolia		f	x	x	f	f	f	f
Gardenia volkensii		f	x	f		f	f	f
Gnidia subcordata	indicator (East African evergreen bushland)		x	x		f	f	
Grewia bicolor	indicator (Lake Victoria evergreen bushland)	f	x	x		f	f	f
Grewia mollis		f	x	x	f	f	C	C
Grewia similis	indicator (East African evergreen bushland)	x	x	x	Cb	x	C	x

Species	Regional status (see section 2.3)	(Ethiopia)	BeeK (Kenya subtype)	BewK (Kenya subtype)	(Rwanda)	(Tanzania)	BemU (Uganda subtype)	BedU (Uganda subtype)
Grewia tembensis	characteristic	x	x	f				
Grewia tenax	not characteristic (indicator for deciduous bushland)	f	f	f		f	f	x
Grewia villosa	not characteristic (indicator for deciduous bushland)	f	x	f		f	f	f
Harrisonia abyssinica		f	x	x	x	f	x	C
Indigofera swaziensis			x	x		f	f	f
Jatropha curcas			x	f		f	f	f
Juniperus procera	characteristic (transition to Afromontane undifferentiated forest)	C	xn	f		f	f	f
Lannea fulva			f	f	x	f	f	f
Lannea humilis	not characteristic (charachteristic for edaphic grassland within deciduous bushland)	f	x	f	f	f	f	x
Lannea rivae		f	x	f		f		
Lannea schimperi		f	x	f	f	f	f	f
Lannea schweinfurthii		f	x	f	f	x	f	x
Lannea triphylla	not characteristic (charachteristic for indicator for deciduous bushland)	f	f	f		f	f	x
Lecaniodiscus fraxinifolius		f	x	x		f	f	f
Lippia kituiensis			x	x		f		
Maerua decumbens	not characteristic (indicator for deciduous bushland)	f	x	f		f	f	f
Maerua triphylla	indicator (Lake Victoria evergreen bushland)	f	x	x	xb	f	f	
Manilkara mochisia			x	f		f		
Margaritaria discoidea		f	f	f		f	x	f
Maytenus heterophylla	indicator (East African evergreen bushland)	f	x	f	xb	f	f	
Maytenus senegalensis		f	x	f	xb	f	f	f
Maytenus undata		f	x	f	xb	f	f	f
Meyna tetraphylla		f	x	f		f	f	f
Olea europaea	indicator (*Olea europaea* ssp. *cuspidata*, synonym: *Olea africana*)	C	xn	x	C	x	f	f
Oncoba spinosa		f	x	x		f	f	f
Opilia campestris		f	x	f		f		
Ormocarpum kirkii			x	f		f		
Ormocarpum trachycarpum		f	x	f		f	f	f
Ormocarpum trichocarpum		f	x	f	f	f	f	f
Osyris lanceolata		f	x	f	x	f	f	f

Species	Regional status (see section 2.3)	(Ethiopia)	BeeK (Kenya subtype)	BewK (Kenya subtype)	(Rwanda)	(Tanzania)	BemU (Uganda subtype)	BedU (Uganda subtype)
Ozoroa insignis		f	xn	x	f	f	f	f
Pappea capensis		C	xn	x	xb	x	f	f
Pavetta crassipes		f	x	x		f	f	f
Pavetta oliveriana		f	f	f	x	f	f	f
Phytolacca dodecandra		f	x	f	f	f	f	f
Pistacia aethiopica		C	x	f		f	f	f
Pittosporum viridiflorum		C	x	f	xe	f	f	f
Plectranthus barbatus		f	x	f		f	f	f
Pleurostylia africana			x	f	f	f	f	f
Premna resinosa	not characteristic (indicator for deciduous bushland)	f	x	f		f	f	f
Psiadia punctulata	indicator (East African evergreen bushland)	x	x			f		
Psydrax parviflora		f	f	f	x	f	f	f
Psydrax schimperiana	indicator (Lake Victoria evergreen bushland)	f	x	x	x	f	f	f
Pterolobium stellatum	indicator (East African evergreen bushland, climber)	f	x	x	f	f	f	f
Rhamnus prinoides		f	x	f	f	f	f	f
Rhamnus staddo		f	x	f	xe	f	f	f
Rhoicissus revoilii		f	f	x	x	f	f	f
Rhoicissus tridentata		f	x	x	x	f	x	x
Rhus longipes		f	f	f	xb	f	f	f
Rhus natalensis	indicator	f	x	x	x	x	x	f
Rhus vulgaris		f	x	x	xb	f	f	f
Rubus volkensii		f	x	f		f	f	f
Sarcostemma viminale	characteristic	f	f	f	x			
Schrebera alata	characteristic (transition to Afromontane undifferentiated forest)	C	xn	f	xbe	f	f	f
Sclerocarya birrea	not characteristic (characteristic for edaphic grassland within deciduous bushland)	f	x	f		f	f	f
Scutia myrtina	indicator (East African evergreen bushland, climber)	f	x	x	x	f	x	f
Securidaca longipedunculata		f	x	f	f	f	f	f
Senna didymobotrya		x	x	f	f	f	f	f
Senna septemtrionalis			f	x	f	f	f	f
Senna singueana		f	x	f	f	f	f	f
Solanecio cydoniifolius			x	f	xb	f	f	f

Species	Regional status (see section 2.3)	(Ethiopia)	BeeK (Kenya subtype)	BewK (Kenya subtype)	(Rwanda)	(Tanzania)	BemU (Uganda subtype)	BedU (Uganda subtype)
Solanecio mannii		f	x	f	xb	f	f	f
Solanum aculeastrum			f	x	f	f	f	f
Steganotaenia araliacea		f	f	x	f	f	f	x
Stereospermum kunthianum		f	x	x		f	f	x
Strychnos henningsii		f	x	f		x	f	f
Strychnos innocua		f	f	f	xb	f	f	f
Strychnos lucens					x	f		
Tarchonanthus camphoratus	indicator (East African evergreen bushland especially in disturbed areas)	C	x	x		f	f	
Tarenna graveolens	indicator (Lake Victoria evergreen bushland)	x	xn	x	x	C	f	x
Tephrosia vogelii			x	f		f	f	f
Terminalia brownii		f	xn	x		f	f	f
Tetradenia riparia		f	x	x	f			
Tinnea aethiopica	indicator (East African evergreen bushland)	f	x	x		f	f	x
Turraea mombassana	indicator (East African evergreen bushland)	x	x			f		
Turraea nilotica	indicator (Lake Victoria evergreen bushland)	f	f	x		f		
Vangueria apiculata		f	x	x	xb	f	x	f
Vangueria infausta			x	x	xb	f	f	f
Vangueria madagascariensis		x	x	x		f	x	f
Vepris nobilis	characteristic genus (synonym: *Teclea*)	f	xn	x	x	C	C	f
Vepris simplicifolia	indicator (East African evergreen bushland)	f	x	x		x		
Vepris trichocarpa	characteristic genus (synonym: *Teclea*)		xn		xb	C		x
Vernonia brachycalyx	indicator (Lake Victoria evergreen bushland, climber)	f	f	x	xb	f	C	f
Warburgia ugandensis		x	f	f		f	f	f
Woodfordia uniflora		f	f	x			f	f
Ximenia americana		f	x	f	f	f	f	f
Zanthoxylum chalybeum		f	xn	f	xb	f	f	x
Zanthoxylum usambarense		C	f	f	f	f		
Ziziphus abyssinica		f	x	x	f	f	f	C
Ziziphus mauritiana		f	x	f		f	f	f
Ziziphus mucronata		f	x	x	f	x	f	f
Ziziphus pubescens		f	x	x		f	x	f

5. Itigi thicket (edaphic vegetation type, bi)

5.1. Description

Itigi thickets are dense deciduous thickets that occur on specialized soils in various drier parts and towards the periphery of the Zambezian floristic region. Itigi thicket took its name from the Tanzanian village of Itigi (5º 42' S, 34º 29' E) where the most extensive manifestation of this vegetation type occurs (White 1983 p. 97).

The soil under Itigi thicket is sandy and varies in depth from 0.6 m to 3 m. It is less stony than many soils under miombo woodland[8] (Wm) and thereby favours the intensive root systems of thicket species. During the rainy season, the soil is well aerated, well supplied with water and soft. The soil dries out during the rainy season (at least in its upper layers) and then hardens considerably. (White 1983 p. 97). For these reasons, Itigi thicket is a vegetation type that is edaphically determined (White 1983 p. 49). Itigi thicket can only regenerate in gaps during periods of high rainfall (C. Ruffo, pers. comm.).

Itigi has a discontinuous distribution in the Zambezian region and occurs in Tanzania (central province), Zambia (in the depressions between Lake Mweru and the southern end of Lake Tanganyika) and a few localities in the Democratic Republic of Congo. Related communities occur in Zambia ("Pemba thicket", see below) and Zimbabwe (White 1983 p. 97).

In Tanzania, Itigi thicket is composed almost entirely of a 3 to 5 m canopy of shrubs that are deciduous for about four months each year. The shrubs have many branches that are interlaced overhead to form a thick continuous cover. The canopy is so dense that light is excluded and a ground layer is virtually absent. Itgi thicket is thornless and climbers are insignificant. It is sharply demarcated from the surrounding miombo woodland (Wm) as there is no transition zone to miombo woodland, although *Brachystegia* trees near the thicket are often stunted. The principal canopy species are ***Baphia burttii, Baphia massaiensis*** (this is also a characteristic species for the 'mutemwa' shrub layer of *Baikiaea plurijuga* Zambezian dry deciduous forest and scrub forest [Fn]), ***Burttia prunoides, Combretum celastroides*** (this is also a characteristic species for the 'mutemwa' shrub layer of *Baikiaea plurijuga* Zambezian dry deciduous forest and scrub forest [Fn] and a characteristic smaller tree species of Chipya woodland [Wy]), ***Grewia burttii***, ***Pseudoprosopis fischeri*** and ***Tapiphyllum obtusifolium***. Emergent species include ***Albizia petersiana*** (8 m), ***Bussea massaiensis*** (smaller) and ***Craibia brevicaudata*** (slightly taller). ***Euphorbia bilocularis*** is a large candelabra euphorbia that only occurs on termite mounds (White 1983 p. 97)).

White (1983) describes the "Pemba thicket" of Zambia as a thicket vegetation type that occurs under similar edaphic circumstances as Itigi thicket. Similar to Itigi thicket, it is named after a village (16 32' S, 27 22' E). Pemba

8:The statement that soils under Itigi thicket are less stony than many soils under miombo woodland is not necessarily true (J. Timberlake, personal communication).

thicket is normally 6 to 7 m tall and almost impenetrable (except locally as a result of local fires or activities from wild pigs and buffaloes). Most thicket species are deciduous, but few species are evergreen. The most abundant thicket species that White (1983) listed include ***Acalypha chirindica*** (also a characteristic species for the 'mutemwa' shrub layer of *Baikiaea plurijuga* Zambezian dry deciduous forest and scrub forest [Fn]), ***Canthium burtii, Combretum celastroides*** (also characteristic in Tanzania and also a characteristic species for the 'mutemwa' shrub layer of *Baikiaea plurijuga* Zambezian dry deciduous forest and scrub forest [Fn] and a characteristic smaller tree species of Chipya woodland [Wy]), ***Haplocoelum foliolosum*** (also a characteristic species for Zambezian rupicolous bushland and thicket), ***Rytigynia umbellulata*** and ***Tarenna neurophylla*** (also a characteristic species for Zambezian rupicolous bushland and thicket).

Several emergent trees are heliophilous ('sun-loving') species that are unable to regenerate in the shade of the Pemba thicket, including ***Brachystegia spiciformis*** (miombo dominant [Wm]) ***Combretum collinum*** (also characteristic for Undifferentiated bushland [Wn] and Chipya woodland [Wy]), ***Pericopsis angolensis*** (also characteristic for miombo woodland [Wm] and other Zambezian woodland types) and ***Pterocarpus angolensis*** (also characteristic for miombo woodland [Wm] and other Zambezian woodland types). ***Margaritaria discoidea*** (also a characteristic species for Afromontane dry transitional forest [Fh]), ***Pteleopsis anisoptera*** and ***Strychnos potatorum*** (also a characteristic species of tall scrub forest [fs] that originally occurred in the Ruzizi valley of Burundi and Rwanda) are expected to be able to regenerate within Itigi thicket, but they rarely emerge far above the canopy.

Figure 5.1 An elephant path within the Itigi thicket (Tanzania). Burtt *et al*. 1942 Photograph 43. Figure obtained from URL: *http://www.jstor.org/stable/2256690.*

Figure 5.2 An open sandy strip separates Itigi thicket (right) from Miombo woodland dominated by *Brachystegia spiciformis* (Wm, left). Burtt *et al.* 1942 Photograph 39. Figure obtained from URL: *http://www.jstor.org/stable/2256690*.

Figure 5.3 Itigi thicket seen from the central railway during colonial times (Tanzania). Burtt *et al.* 1942 Photograph 40. Figure obtained from URL: *http://www.jstor.org/stable/2256690*.

5.2. VECEA region

Within the VECEA region, Itigi thicket only occurs in Tanzania and Zambia (Figure 5.4, see also Volume 6). We could not identify the "Pemba" thicket of Zambia on the map, although we checked around Pemba (16º 32' S, 27º 22' E).

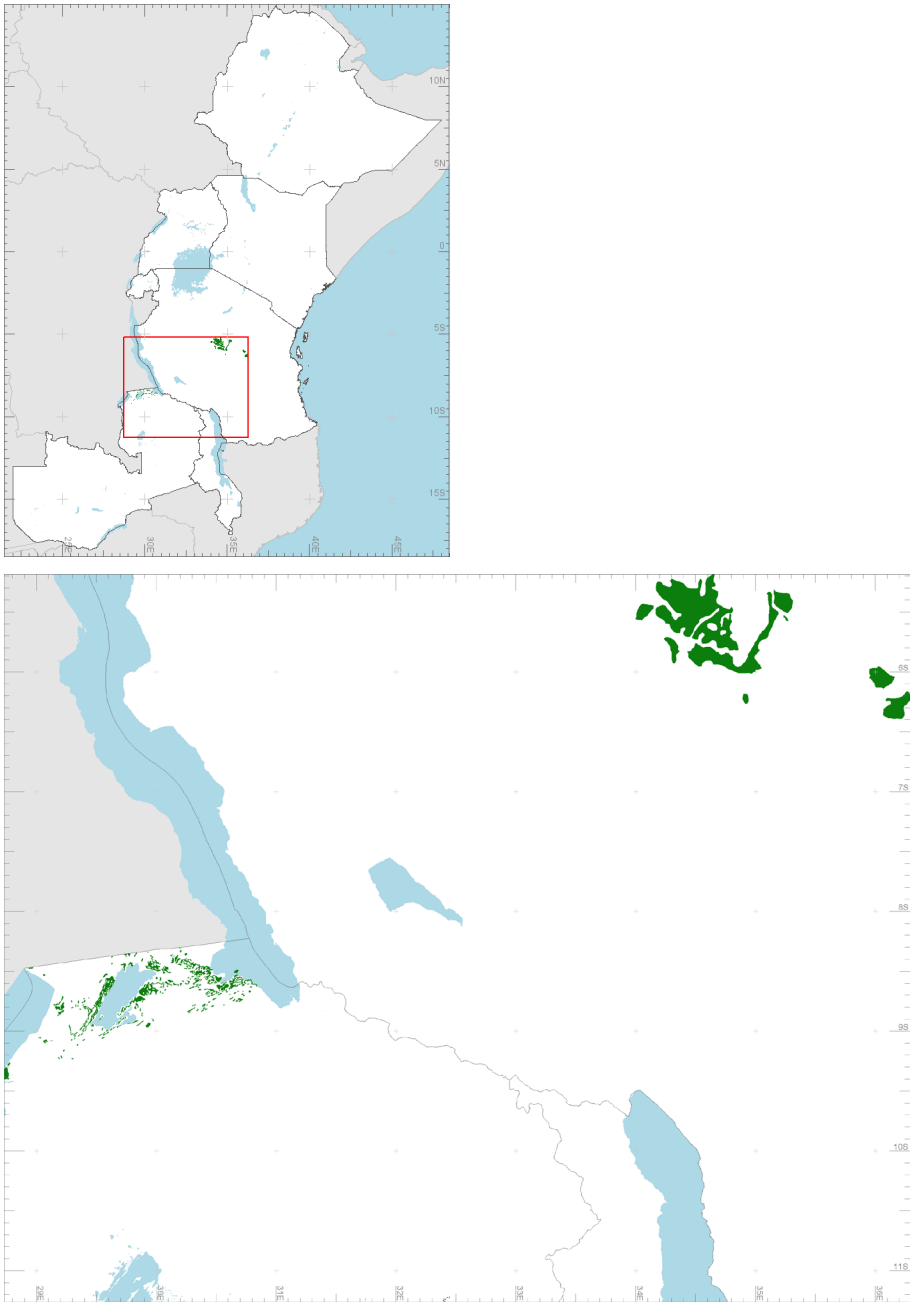


Figure 5.4. Mapped distribution of Itigi thicket in the VECEA region (Ethiopia, Kenya, Malawi, Rwanda, Tanzania, Uganda and Zambia). Green polygons depict where we mapped this vegetation type. Some isolated patches occur between 32 and 33 degrees East on the south of the map shown on the right

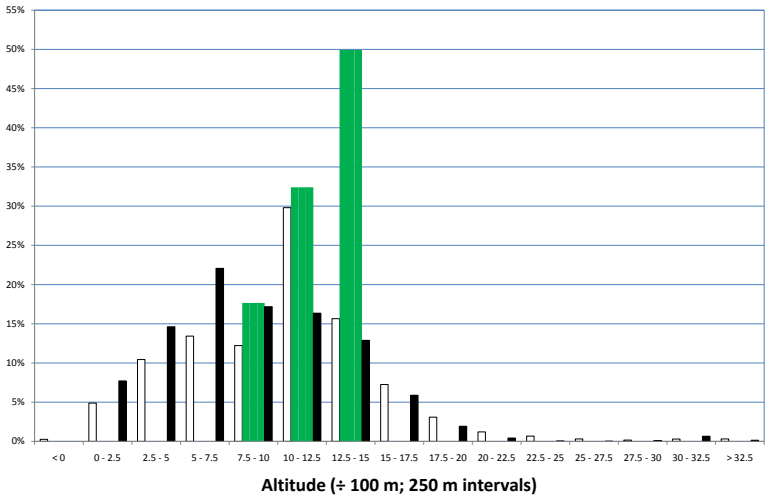
In Tanzania, Gillman (1949 p. 14) mapped and described Itigi thicket as one of the three "thickets of regional extent". He describes it as a dense and fully closed thicket of coppicing shrubs of 2.5 to 5 m high that covers between 5000 and 6000 square kilometres. He mentions that the presence of Itigi thicket is a result from edaphic differences and that it is an important natural barrier against tsetse flies. Commenting on the distribution of miombo woodland (Wm), Gillman (1949) also indicates that the distribution of Itigi thickets coincides with that of too well or too rapidly draining Pliocene duricrusts.

In Zambia, Fanshawe (1971 pp. 25 - 26) describes Itigi thicket in Zambia as a type of dry deciduous forest, although he also mentions that Trapnell used the name of "*Bussea-Combretum* thicket (mapping unit B3 [9])" for this "forest". Itigi thicket has a very open overwood of deciduous or semi-deciduous emergents 6 - 12 m high characterized by ***Baphia massaiensis,*** *Boscia angustifolia*, ***Burttia prunoides, Bussea massaiensis***, *Diospyros mweroensis* and *Euphorbia candelabrum*. The trees are often encrusted with lichens. About 25% of species also occur in the great Itigi thicket of Tanzania and a further 33% of species are floristically closely related. Conditions are also similar as in Tanzania where there is ample water during the rainy season and little or no water during the dry season as a result from impeded drainage (either by stones and rubble near the surface on soils on lowlands or by skeletal stony soils on the gentle lower scarp slopes; Fanshawe 1971 p. 25. Total destruction of Itigi thicket leads to Chipya woodland that can not be distinguished from the Chipya woodland (Cy) that results from total destruction of *Marquesia* dry evergreen forest (Fm; *i.e.* lake basin chipya; see Volume 2). Since Itigi thicket is highly sensitive to disturbance, there is no partial destruction catena (although ***Baphia massaiensis*** may be found as relic in Chipya woodland ; Fanshawe 1971 p. 26).

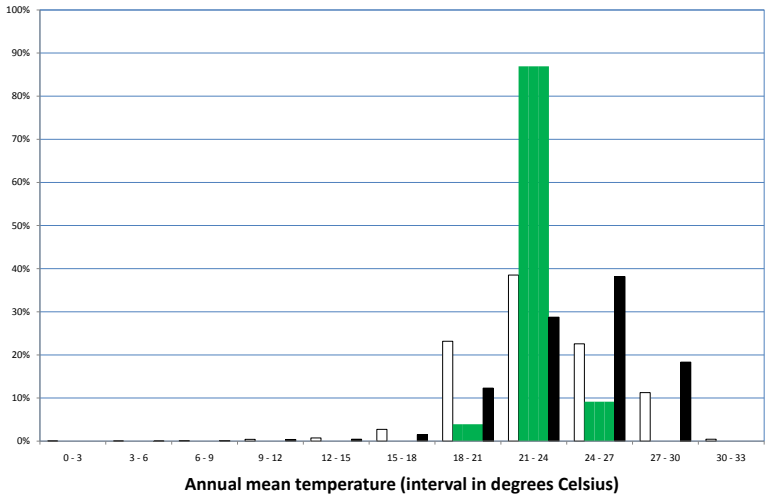
Investigation of environmental distribution of Itigi thicket in the VECEA region (Figure 5.5) shows that all samples occur in an interval from 750 – 1500 m. This altitude interval is in between those where most deciduous bushlands (Bd, 0 – 1500 m) and evergreen bushlands (Be, 1000 – 2250 m) occur. The altitude interval of 1250 – 1500 m contains the highest number of samples (49.9%); this is the same altitude interval that contains the highest number of samples of evergreen bushland (Be; 35.9%). Evergreen bushland (Be) generally receives between 400 and 1200 mm annual rainfal (almost all samples); this is the same interval where most evergreen bushland (Be) occurs. The rainfall interval of 600 – 800 mm contains the highest number of samples (65.3%) for this vegetation type. This interval is just below the rainfall interval of 800 – 1000 mm that contains the highest number of samples for evergreen bushland (Bd; 41.8%).

9: The coding of the Trapnell *et al.* (1950) vegetation - soil map is based on the soil type with a suffix for the vegetation type. In the legend of the Fanshawe vegetation map (Edmonds 1976), an indicating is given that Itigi forest corresponds to B3 (Bussea - Combretum thicket and associated open vegetation on soils of Lake Basin type [or the "Itigi thicket" of Tanzania, Trapnell *et al.* 1950 p. 19]).

(a)



(b)



(c)

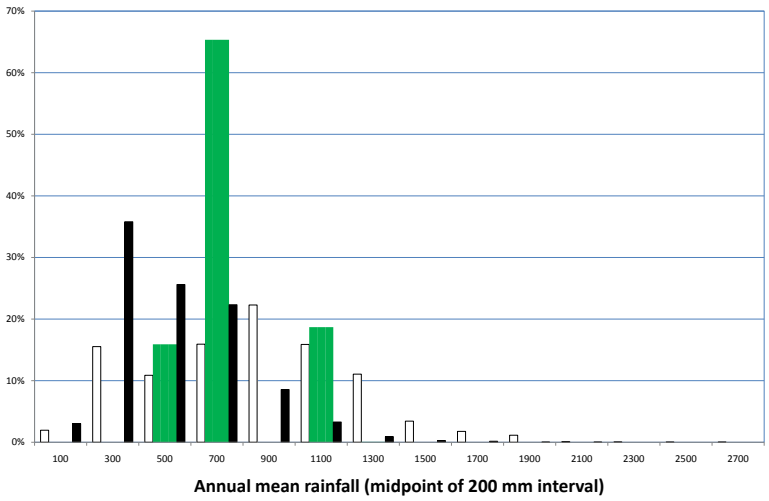


Figure 5.5. Histograms of the distribution of altitude (a), mean annual temperature (b) and mean annual rainfall (c). Bars at the centre of each interval show the percentage of samples within Itigi thicket (bi, *n* = 1,552). Bars on left (open) show the overall percentage of samples (*n* = 740,047). Bars on the right (black) show the percentages of samples within bushlands or thickets (including all vegetation types that are described in this volume, *n* = 250,418).

5.3. Species composition

Species assemblages were obtained from the following references:

- Tanzania: White (1983 p. 97). All species listed were coded "C" (all species were assumed to be characteristic species).
- Zambia: Fanshawe (1971). Species listed for the species composition table for "Dry deciduous forest - Itigi forest" provided on pages 27 to 28 were coded "x" (unless they were characteristic species). Species listed in the main text to occur in the "Itigi Chipya" were coded "xc".
- Pemba thicket: White (1983 p. 98). Species that were mentioned were coded "x".

Characteristic species were determined as:

- Tanzania: All species were assumed to be characteristic species.
- Zambia: Species listed to occur as emergents were coded "C".
- Pemba thicket: Species that were **not** listed as heliophilous species (species that do not regenerate in the shade of the thicket) were coded "C".

Within the information on assemblages, coding "f" indicates that there is information that the species **potentially** occurs in the vegetation type since it occurs in the focal country and in the same bushland type in other countries (see section 2.3).

Table 5. Species composition of Itigi thicket (edaphic vegetation type, bi)

Species	Regional status (see section 2.3)	(Tanzania)	(Zambia)	Pemba thicket
Acacia polyacantha		f	xc	
Acalypha chirindica	indicator (Pemba, also shrub layer ['mutemwa'] of *Baikiaea* forest)	f	x	x
Afzelia quanzensis		f	xc	
Albizia antunesiana		f	xc	
Albizia petersiana	indicator (Itigi, emergent)	C		
Baphia burttii	indicator (Itigi)	C		
Baphia massaiensis	indicator (Itigi, also shrub layer ['mutemwa'] of *Baikiaea* forest)	C	C xc	
Boscia angustifolia		f	C	
Brachystegia spiciformis	indicator (Pemba, emergent, also dominant in Miombo woodland)			x
Burkea africana		f	xc	
Burttia prunoides	indicator (Itigi)	C	C	
Bussea massaiensis	indicator (Itigi, emergent)	C	C	
Canthium burtii	indicator (Pemba)		C	C
Cassia abbreviata		f	C	
Cassipourea malosana		f	C	
Combretum adenogonium		f	xc	
Combretum celastroides	indicator (also shrub layer ['mutemwa'] in *Baikiaea* forest and chipya woodland)	C	C	C
Combretum collinum	indicator (Pemba, emergent, also undifferentiated woodland and Chipya woodland)	f	xc	x
Combretum zeyheri		f	C	
Commiphora africana		f	C	
Craibia brevicaudata	indicator (Itigi, emergent)	C	f	
Diospyros abyssinica		f	C	
Diplorhynchus condylocarpon			xc	
Erythrophleum africanum		f	xc	
Euphorbia bilocularis	indicator (Itigi, only on termite mounds)	C		
Euphorbia candelabrum		f	C	
Grewia burttii	indicator (Itigi)	C		
Haplocoelum foliolosum	indicator (Pemba)	f	x	x
Landolphia kirkii		f	x	
Lannea discolor	indicator (Pemba, also in various types of Zambezian woodland)			x
Lannea humilis		f	x	
Margaritaria discoidea	indicator (Pemba, emergent)	f	x	C
Parinari curatellifolia	positive indicator (Pemba, emergent, also various types of Zambezian woodland)			x
Peltophorum africanum	characteristic (Pemba, emergent, also widespread in Zambezian termite-mound thicket)			x
Pericopsis angolensis	indicator (Pemba, emergent, also various types of Zambezian woodland)	f	xc	x
Pseudolachnostylis maprouneifolia		f	C xc	
Pseudoprosopis fischeri	indicator (Itigi)	C	x	
Pteleopsis anisoptera	indicator (Pemba, emergent)	f	C	C
Pterocarpus angolensis	indicator (Pemba, emergent, also various types of Zambezian woodland)	f	xc	x

Species	Regional status (see section 2.3)	(Tanzania)	(Zambia)	Pemba thicket
Pterocarpus rotundifolius	indicator (Pemba, emergent, also undifferentiated woodland)			x
Rytigynia umbellulata	indicator (Pemba)	f	x	C
Sclerocarya birrea		f	xc	
Strychnos potatorum	characteristic (Pemba, emergent, also in Zambezian termite-mound thicket and rupicolous bushland and thicket)			C
Tapiphyllum obtusifolium	indicator (Itigi)	C		
Tarenna neurophylla	characteristic (Pemba, also rupicolous bushland and thicket)	f	C	x
Terminalia mollis		f	xc	
Terminalia sericea		f	xc	
Vangueria infausta		f	x	
Vitex mombassae		f	x	
Ximenia americana		f	x	
Zanthoxylum chalybeum		f	x	

6. Riverine thicket (edaphic vegetation type, br)

6.1. Description

White (1983) describes riparian forests (coded in VECEA as "fr", see Volume 2), but no riparian thickets.

6.2. Description

Within the VECEA region, riverine thicket was only described for Uganda. In the VECEA map, we mapped this vegetation type together with riverine forests (fr) and woodlands (wr).

Riverine thicket was originally mapped in Uganda as "riparian thicket" (original mapping unit G2). Langdale-Brown *et al.* (1964 pp. 53 - 54) describe that riverine thickets and riverine mixed thicket and woodlands occur as natural climax communities on the banks of seasonal rivers in east and central Karamoja. They also describe communities of different species composition (a "third phase") that occur along the base of the Turkana escarpment and below the Chemorongit range.

6.3. Species composition

Species assemblages were obtained from the following references:

- Uganda: Langdale-Brown *et al.* (1964). All species that were listed to occur in "Riparian moist thicket" (G2) in the Appendix were coded "x" (unless they were characteristic species).

Characteristic species were determined as:

- Uganda: species that were mentioned in the main reference text were coded "C".

Species assemblage information was provided in a separate column ("brU") in the species assemblage table for riverine forest (fr, volume 2).

7. Montane Ericaceous belt (easily identifiable type, E)

7.1. Description

White (1983) refers to Afromontane evergreen bushland and thickets that occur on most of the higher African mountains and that characteristically occupy a large part of the Ericaceous mountain belt. They are also found on the crests and summits of smaller mountains (especially those that are situated close to the ocean or a large lake) or locally on shallow soils within the Afromontane forest belt. Where the ground is not very rocky and has been protected for several years, such as on wetter mountains as the Ruwenzori Mts., almost impenetrable thickets of 3 to 13 m are formed. On drier and rocky slopes, the vegetation is an open community of bushes that is often discontinuous and merges into Afromontane shrubland (see below). Afromontane evergreen bushland and thicket varies greatly in floristic compo-sition, but species of the *Blaeria*, *Erica* and *Vaccinium* Ericaceae genera are nearly always present and sometimes exclusively dominant (White 1983 p. 167 - 168). Hedberg (1951 cited in Friis *et al.* 2010 p. 113) has documented that an Ericaceous belt occurs on all the high mountains of eastern Africa.

Afromontane shrubland occurs on shallow soils and especially exposed rocky ridges. It is much shorter than Afromontane evergreen bushland and thicket and contains stunted invididuals that are dominant in the latter vegetation type. However, Afromontane shrubland also contains species that are usually absent from Afromontane evergreen bushland and thicket (White 1983 p. 168).

Ericaceous vegetation occurs at a few places on the East African coast. Evergreen bushland dominated by *Erica* (synonym: Philippia) occurs on waterlogged sites of former lagoons or lake basins (White 1983 p. 188). Interestingly, *Syzygium cordatum* is an associate that is listed both for Ericaceous vegetation on Mafia and Pemba islands (White 1983 p. 189) and for tall "elfin" thickets (3 - 7 m) that occur on peaks in the Uluguru mountains (White 1983 p. 168). We did not include coastal Ericaceous vegetation types into the "montane Ericaceous belt" as coastal vegetation is clearly not associated with mountains.

Figure 7.1 Ericaceous belt with *Erica arborea* forming woodland. The floor is completely covered by ferns, mosses and grasses. Bale Mountains (Ethiopia). Approximate altitude 3600 m. Photograph by I. Friis and Sebsebe Demissew (September 2005). Reproduced from Biologiske Skrifter of the Royal Danish Academy of Sciences and letters, Vol. 58, Fig 29A. 2010.

Figure 7.2 Ericaceous belt with *Erica arborea* forming woodland. This location has more grass than the location shown in Fig EA. Bale Mountains (Ethiopia). Approximate altitude 3300 m. Photograph by I. Friis and Sebsebe Demissew (September 2005). Reproduced from Biologiske Skrifter of the Royal Danish Academy of Sciences and letters, Vol. 58, Fig 29C. 2010.

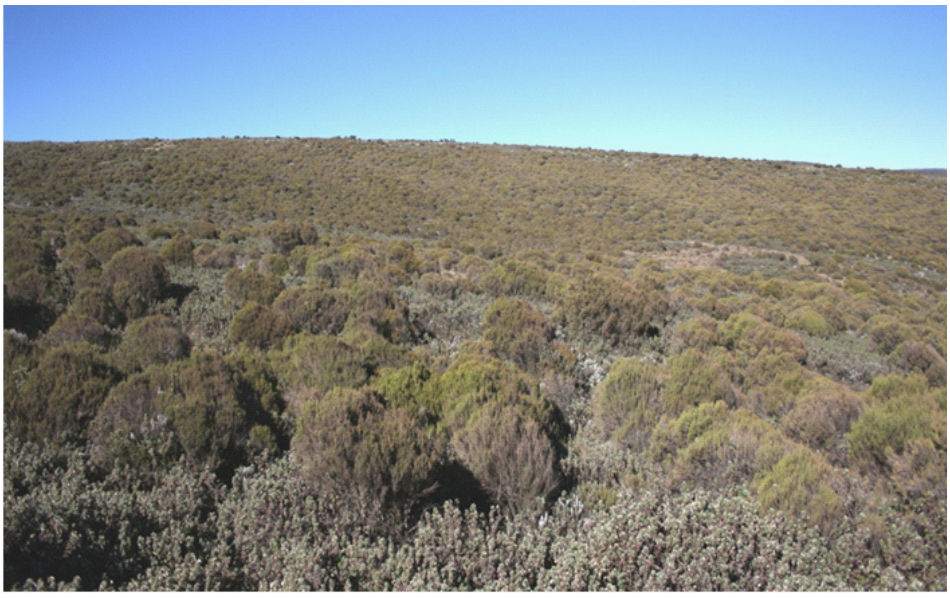


Figure 7.3 Ericaceous belt with burnt vegetation. Numerous shoots (green) appear from the burnt stumps of *Erica arborea*. In between the *Erica arborea* stumps and in the foreground, the subshrub *Alchemilla haumannii* (greyish-green) can be seen. Bale Mountains (Ethiopia). Approximate altitude 3800 m. Photograph by I. Friis and Sebsebe Demissew (September 2005). Reproduced from Biologiske Skrifter of the Royal Danish Academy of Sciences and letters, Vol. 58, Fig 29B. 2010.

Left: Figure 7.4. The montane Ericaceous belt on Mt. Kahuzi (Kahuzi-Biega-National Park, D.R.Congo. Photograph by E. Fischer (October 1991).

Right: Figure 7.5. *Vaccinium stanleyi*, one of the Ericaceae species of the Ericaceous belt in Rwanda (Mt. Kahuzi, Kahuzi-Biega-National Park, D.R.Congo). Photograph by E. Fischer (October 1991).

Figure 7.8 *Erica kingaensis* subsp. *rugensis*, one of the Erica species of the Ericaceous belt in Rwanda. Rwasenkoko Swamp, Nyungwe National Park. Photograph by E. Fischer (October 1985).

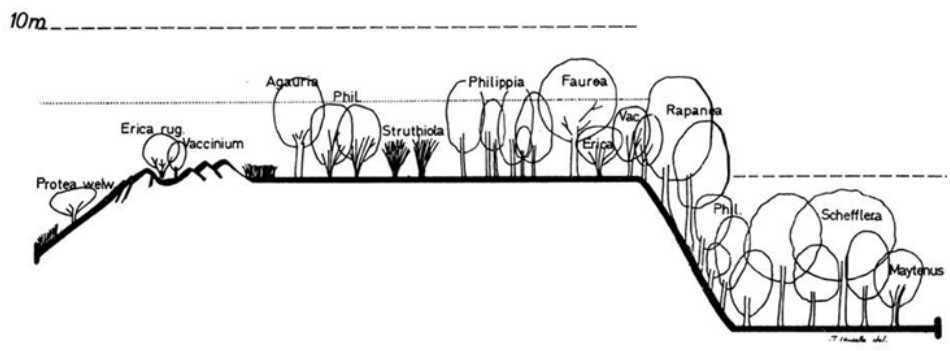


Fig. 28. — Profil-diagramme de la fruticée sclérophylle à *Ericaceae*.

Figure 7.7 Profile diagram of Afromontane Ericaceous bushland ("fruticée sclérophylle à Ericaceae", i.e. sclerophyl scrubland with Ericaceae). This image was the only profile diagramme mentioned by White (1983 p. 167) for Afromontane evergreen bushland and thicket. Vegetation similar to the Ericaceous belt occurs on the crests and summits of some smaller mountains as shown below. Lewalle 1972 Fig 28. Figure obtained from URL URL: http://www.jstor.org/stable/3667406

7.2. VECEA region

We did not distinguish between the bushland, thicket and shrubland variants of the Afromontane Ericaceous belts and described these communities collectively as the montane Ericaceous belt. Within the VECEA region, the Ericaceous vegetation occurs in all countries (Figure 7.5, see also Volume 6). In Zambia, however, we do not expect that typical montane Ericaceous belts occur.

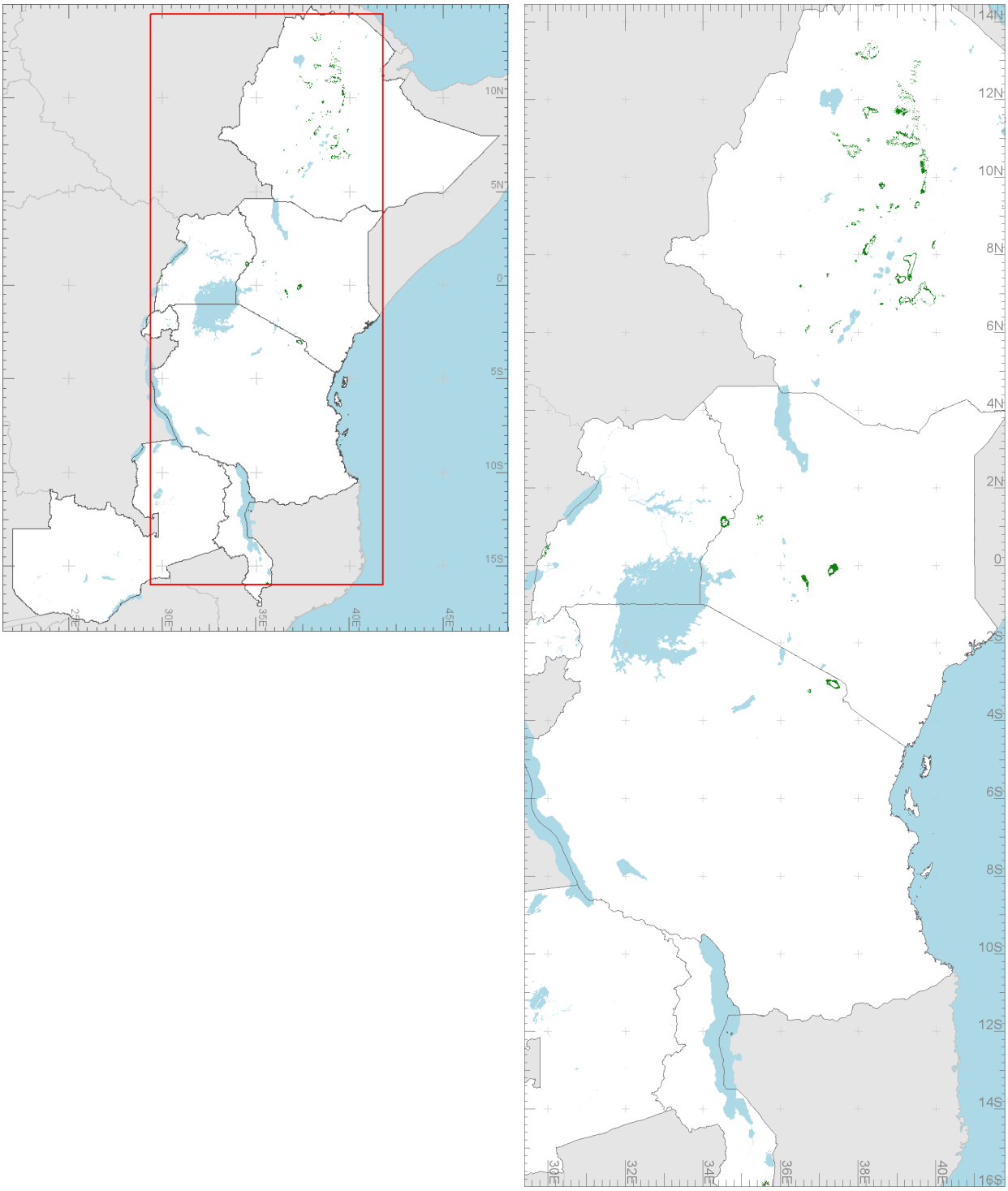


Figure 7.5. Mapped distribution of the montane Ericaceous belt in the VECEA region (Ethiopia, Kenya, Malawi, Rwanda, Tanzania, Uganda and Zambia). Green polygons depict where we mapped this vegetation type. In Malawi, the montane Ericaceous belt only occurs on Mt. Mulanje, in the south of this country. In Zambia we do not expect that montane Ericaceous belts occur.

In Ethiopia, the montane Ericaceous belt was originally described and mapped as "Ericaceous belt" (EB). Friis *et al.* (2010 p. 113) emphasize that vegetation in which Ericaceous species form an important component may occur at higher or lower altitudes than the "Ericaceous belt" that they mapped by the contour lines of 3000 and 3200 m (given the steepness of most of the slopes, using slight variations in altitudinal limits would not have resulted in large variations in the extend of this vegetation type on the map).

In Kenya, the montane Ericaceous belt was originally mapped as "high mountain scrub types, undifferentiated" (original mapping unit 15) and "tree heather, thicket and scrub" (original mapping unit 15a).

Shaxson (1976) included "Afro-alpine heath and moorland" in the legend of the vegetation and biotic communities map of Malawi, but indicated that this vegetation type was not mappable at a scale of 1 : 1,000,000. In the documentation of the map, Shaxson (1976) describes that the montane shrubland and montane shrub grassland on the uppermost slopes of Mt. Mulanje can be regarded as belonging to the Ericaceous zone (citing Chapman and White 1970 p 71). He further mentions that no other site in Malawi harbours this vegetation type. We did not find Malawian references where species composition of this vegetation type was provided.

In Rwanda, the montane Ericaceous belt was originally described as "bruyères (arborescents)".

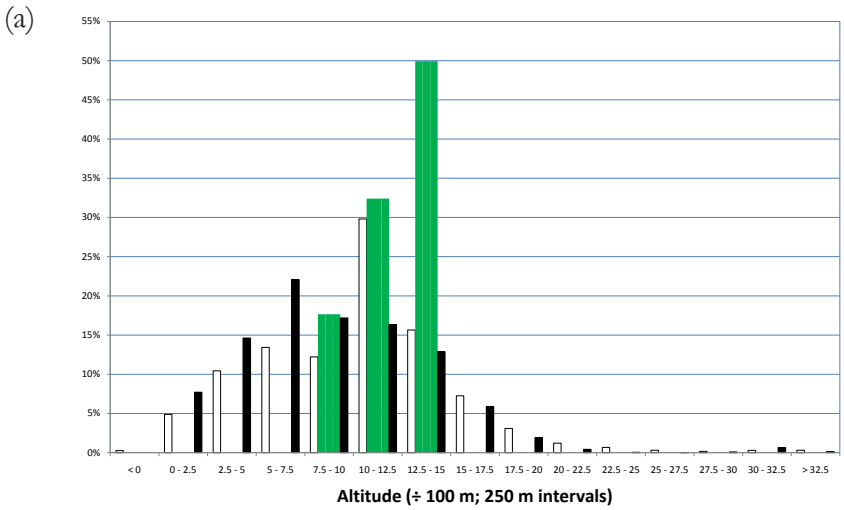
For Tanzania, Lovett (1993) mentions that Ericaceous belts occur on Mts. Kilimanjaro (3250 - 4100m), Meru (3000 - 3700m) and Hanang (> 3000 m). In the southern highlands there is no well defined Ericaceous belt, except possibly on Mt. Rungwe. On the west Usambara Mts., there are small patches on exposed ridge tops above 1800 m. In the Uluguru Mts., elfin mossy forest on ridgetops and forest edges above 2000 m with frequent mists is thought to have replaced the Ericaceous belt. He says that fire is an important factor for Ericaceous vegetation to replace montane forest.

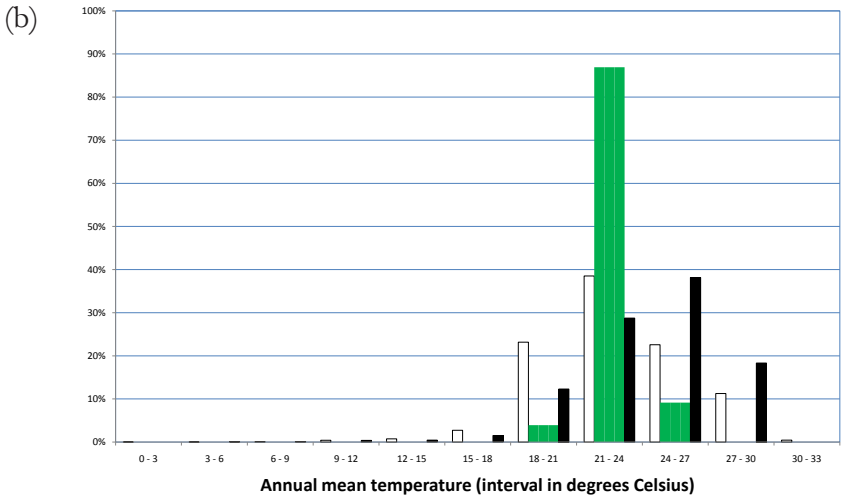
In Uganda, the montane Ericaceous belt was originally described and described as "Ericaceae - *Stoebe* Heath" (original mapping unit A2). *Stoebe kilimandscharica* is a species that was listed to be characteristic in Uganda. This is a species from the Asteraceae family that is as abundant as characteristic Ericaceae species ("true heathers") on Mt. Elgon (Langdale-Brown *et al.* 1964 p. 33).

Ericaceous vegetation was not mapped or described by Fanshawe (1971) to occur in Zambia. However, in the legend of the Fanshawe vegetation map (Edmonds 1976) an indicating is given that Montane forest (mapping unit 8 in the Fanshawe map) is mapped within mapping unit E3 of the soil - vegetation map of Zambia (Trapnell *et al.* 1950). Trapnell *et al.*'s mapping unit E3 is "*Philippia* scrub - grassland on mountain summits". This vegetation type is described by Trapnell *et al.* (1950 p. 20) as scrub - grassland or moorland of *Philippia milanjiensis* (current name: *Erica benguelensis*) with *Protea*

and *Vellozia sp*. and also with short sedge or grass growth, a vegetation type that occurs on mountain summits in east Isoka District. Sheet II of the vegetation - soil map shows this mapping unit on the Matingi (10º 00' S, 33º 22' E) and Mwanda Mts (10º 34' S, 33º 31' E). White (1983 p. 99) mentions that *Erica benguelensis* is a characteristic member of Ericaceous montane shrubland that is also normally found in miombo scrub woodland near the altitudinal limits of miombo. However, Fanshawe (1971 p. 30) lists *Philippia milanjiensis* as one of the main shrub species of montane forests (Fa and Fb) and also as an occasional relic in fire-derived upland grassland. We conclude that Ericaceous vegetation does occur marginally in Zambia, but not as the typical Ericaceous belts that are described for other countries.

Investigation of environmental distribution of the montane Ericaceous belt in the VECEA region (Figure 7.6; limits are for areas of the VECEA map where this vegetation type is not mapped as mosaic) shows that more than 95% of the samples occur above 2750 m, well above the altitudinal ranges of other bushland and thicket vegetation types. The montane Ericaceous belt generally receives between 800 and 1800 mm annual rainfall (94.9% of samples). The rainfall interval of 1000 – 1200 mm contains the highest number of samples (42.1%) for this vegetation type; no other bushland or thicket vegetation type has such high rainfall interval where most of their samples occur.





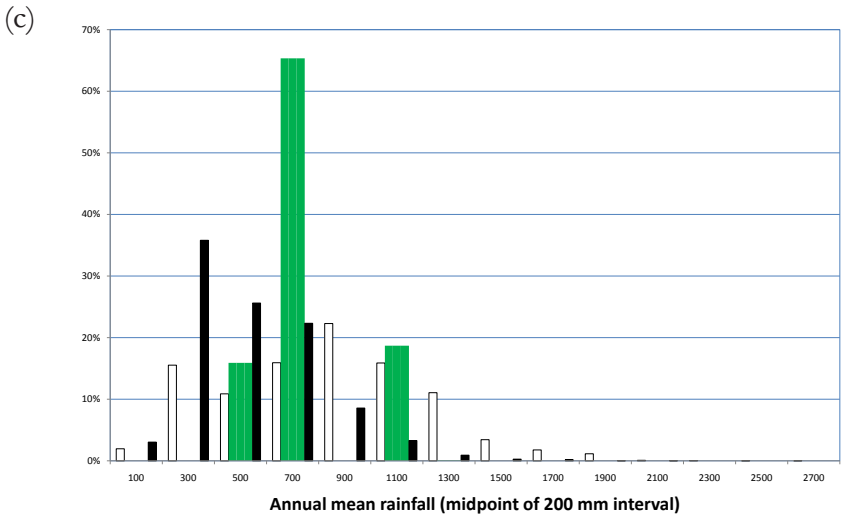


Figure 7.6. Histograms of the distribution of altitude (a), mean annual temperature (b) and mean annual rainfall (c). Bars at the centre of each interval show the percentage of samples within the Afromontane Ericaceous belt (E, *n* = 2,316). Bars on left (open) show the overall percentage of samples (*n* = 740,047). Bars on the right (black) show the percentages of samples within bushlands or thickets (including all vegetation types that are described in this volume, *n* =250,418).

7.3. Species composition

Species assemblages were obtained from the following references:

- Ethiopia: Friis *et al.* (2010). Species mentioned in Appendix 3 for "Ericaceous belt" [EB] were coded "x" (unless they were characteristic species).
- Kenya: Species that were expected to occur in Ericaceous vegetation based on information from Beentje (1994), the Flora of Tropical East Africa and field experience from our Kenyan co-author (F. Gachathi) were coded "x".
- Malawi: No details were obtained for this vegetation type. Therefore only floristic commitments were made ("f").
- Rwanda: Bloesch *et al.* (2009). All species that were mentioned to occur in floristic region 4 (volcano zone) and where a reference was made to 'bruyères (arborescents)' [(10)] in the description of their ecology were coded "x" (unless they were characteristic species).
- Tanzania: Hedberg O. (1951). Vegetation belts on the East African mountains. Svensk Bot. Tiskr. 45: 140-202. All species that were mentioned to occur in the Ericaceous belts of Mts. Kilimanjaro and Meru were coded "C".
- Uganda: Langdale-Brown *et al.* (1964). All species that were listed to occur in "Ericaceae-Stoebe Heath" (original mapping unit A2) in the Appendix were coded "x" (unless they were characteristic species).

Characteristic species were determined as:

- Ethiopia: Those species that were mentioned in the description of the vegetation type in the main text were coded as "C".
- Kenya: Species from the Ericaceae family were coded "C".
- Malawi: No characteristic species were identified
- Rwanda: Species from the Ericaceae family were coded "C".
- Tanzania: all species that were listed were assumed to be characteristic species.
- Uganda: species that were mentioned in the main reference text were coded "C".

Within the information on assemblages, coding "f" indicates that there is information that the species **potentially** occurs in the vegetation type since it occurs in the focal country and in the same bushland type in other countries (see section 2.3).

10: 'bruyères' are defined as plant formations that are mainly composed of Ericaceae (Bloesch *et al.* 2009 p. 649).

Table 7. Species composition of the montane Ericaceous belt (easily identifiable type, E)

Species	Regional status	(Ethiopia)	(Kenya)	(Malawi)	(Rwanda)	(Tanzania)	(Uganda)
Agauria salicifolia	Ericaceae	f	C	f	C	f	f
Erica arborea	Ericaceae	C	C		f	C	x
Erica benguelensis	Ericaceae		f	x	f	f	C
Erica excelsa	Ericaceae		C			C	
Erica johnstoniana	Ericaceae			f			C
Erica johnstonii	Ericaceae				f		x
Erica kingaensis	Ericaceae				f	f	x
Erica milanjiana	Ericaceae			x			
Erica trimera	Ericaceae	C	C			f	C
Erica whyteana	Ericaceae		f	x		f	
Adenocarpus mannii		x	x	f	f	C	f
Aeschynomene abyssinica		x	f	f		f	f
Aloe arborescens				x			
Artemisia afra			x				
Asparagus africanus		x	f			f	
Asparagus racemosus		x	f			f	
Berberis holstii		x	x	f		f	f
Buddleja polystachya		x	f			f	f
Cassipourea malosana		x	f	f		f	f
Clematis hirsuta		x			f		
Clematis simensis		x	x		f	f	f
Clutia lanceolata		x	f				
Conyza newii		x	f		f	f	f
Cornus volkensii			x	f	f	f	f
Crotalaria agatiflora		x	f	f	f	f	f
Discopodium eremanthum		x	x			f	f
Discopodium penninervium		x	f	f	f	f	f
Dombeya torrida		x	x	f	f	f	f
Eragrostis nindensis				x			
Faurea saligna			x	f	f	f	x
Galium ruwenzoriense			f			f	x
Gnidia glauca		x	x	f		f	f
Hagenia abyssinica		x	x	f	f	f	f
Halleria lucida		x	f	f		f	f
Helichrysum formosissimum			x		f		
Hypericum quartinianum		f	x	f		f	f
Hypericum revolutum		C	x	f	f	f	x
Inula confertiflora		x					
Juniperus procera		x	f	f		f	f
Kotschya recurvifolia		f	x	f		f	
Leonotis ocymifolia		x	f			f	
Lobelia rhynchopetalum		x					
Lobelia stuhlmannii					f		x
Maesa lanceolata		f	x	f	f	f	f
Maytenus undata		x	f	f	f	f	f
Morella salicifolia		x					
Myrsine africana		x	f	f	f	f	f
Nuxia congesta		x	f	f	f	f	f

Species	Regional status	(Ethiopia)	(Kenya)	(Malawi)	(Rwanda)	(Tanzania)	(Uganda)
Olea capensis		x	f	f	f	f	f
Olinia rochetiana		x	f	f	f	f	f
Otostegia tomentosa		x					
Pavonia urens		x	f	f	f	f	f
Pittosporum abyssinicum		x	f		f	f	f
Podocarpus latifolius			x	f	f	f	f
Prunus africana		f	x	f	f	f	f
Rapanea melanophloeos		C	x	f	f	f	f
Rhamnus prinoides		x	f	f	f	f	f
Rhus glutinosa		x					
Rosa abyssinica		x					
Rubus volkensii		x	f			f	f
Senecio maranguensis			x		f	f	f
Senecio myriocephalus		x					
Sinarundinaria alpina	Afromontane bamboo	x	f	f	f	f	f
Solanecio gigas		x					
Sparrmannia ricinocarpa		x	f	f		f	f
Struthiola thomsonii		f	x		f	f	
Tephrosia aequilata			x	f	f	f	f
Toddalia asiatica		x	f	f	f	f	f
Widdringtonia nodiflora				C			

8. Termitaria vegetation (easily identifiable and edaphic type, including bush groups around termitaria within grassy drain age zones, T)

8.1. Description

Termite mounds that are more than a metre in diameter are usually covered with dense thickets, unless they have been newly built or are in the final stages of erosion. The species composition of these thickets is completely different from that on the surrounding soil. This pattern is particularly true for the Zambezian region where the flora of termite-mound thickets is extremely high (with more than 700 woody species occurring in this habitat in Zambia alone; White 1983 p. 98).

In the Zambezian region, the flat valley bottoms of larger rivers are usually flooded annually or at least seasonally waterlogged. Where the flood water is shallow, "bush-group" grassland often occurs extensively; this is a mosaic of pure grassland and termite-mound thicket (White 1983 p. 100). A similar pattern occurs in the Zanzibar-Inhambane region where dense thickets occur in seasonally-waterlogged grasslands in parts of the coastal plain (White 1983 p. 189). This vegetation type could potentially be described as "wooded grassland", but treating it as a patchwork or mosaic of pure edaphic grassland and sharply defined islands of thickets that occur on the better drained soils of old eroded termite mounds gives a better description of this vegetation type.

From the widespread species that White (1983) listed, the following species were encountered in the Zambian national reference: ***Carissa spinarum, Diospyros lycioides, Euphorbia candelabrum, Flueggea virosa, Peltophorum africanum, Rhoicissus tridentata, Steganotaenia araliacea*** and ***Strychnos potatorum*** (White 1983 p. 98).

Figure 8.1 Lateral view of a large example of mopane *termitaria* vegetation. The large trees are mopane (roughly 25 m). Photograph by C. Dudley.

Figure 8.2 *Termitaria* vegetation in Kafue National Park (Zambia). The sides with a south-western exposure carry trees, whereas the sides with a north-eastern exposure carry only grassland. Cole 1963 Fig 9. Image obtained from URL: http://www.jstor.org/stable/1794828.

Figure 8.3 T. Mopane termitaria vegetation result in a distinct pattern on aerial photographs. Each patch of Mopane termitaria vegetation is between 10 and 20 m in diameter. Photograph by C. Dudley.

8.2. VECEA region

Within the VECEA region, termitaria vegetation was described for the national vegetation maps of Malawi, Tanzania and Zambia (see Volume 6). This vegetation type was also described for the coastal areas of Kenya and Tanzania (Zanzibar-Inhambane termite mounds in seasonally waterlogged grassland, White 1983 p. 189). Termitaria vegetation was only mapped in Zambia were it occurs as part of the "bush groups" mosaic (original mapping unit 16, see below).

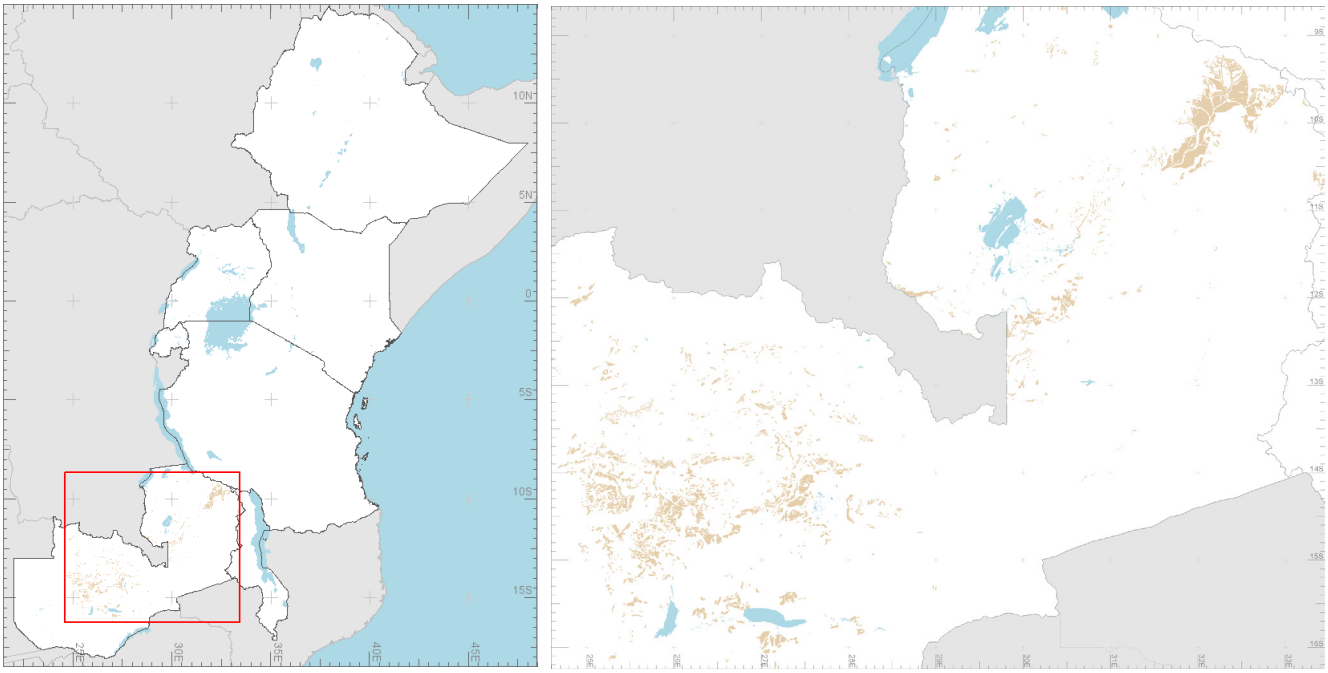


Figure 8.4 Mapped distribution of *termitaria* vegetation in the VECEA region (Ethiopia, Kenya, Malawi, Rwanda, Tanzania, Uganda and Zambia). Greyish-brown polygons depict where this vegetation type was mapped as part of vegetation mosaics with edaphic grassland in Zambia. This vegetation type has a much wider distribution than shown here.

In Malawi, the pattern of clumps with mopane (*Colophospermum mopane)* termitaria vegetation that are scattered by wide grassy glades is distinctive in aerial photographs (Figure 8.3). This mopane termitaria vegetation occupies an area of a few hundred km^2. Large (6 - 10 m diameter) termitaria contain a limited but repetitive number of species, with several large (20 – 25 m) *Colophospermum mopane* as dominant canopy trees. Most *termitaria* are inactive and in decline as a result to erosion. The *termitaria* appear regularly dispersed and are separated by wide grassy glades on soil which generally remains saturated during the rainy season. The average woody tree cover in these landscapes is considerable greater than 10% and smaller than 40% (C. Dudley, personal observations).

Information on species composition for Malawi was restricted to mopane *termitaria* since these have been studied in detail by our Malawian co-author (C. Dudley). *Termitaria* occur in other vegetation types in Malawi such as flood plains, riverine vegetation or Zambezian dry deciduous forest (Fn). In these other termitaria, *Colophospermum mopane* seldom, if ever, occurs (C. Dudley, personal observations).

Gillman (1949 pp. 24-25) indicates that termitaria vegetation (he uses the synonym of "thickets on termite mounds") occur as "intrazonals" [(11)] in permanent swamp vegetation in Tanzania. Gillman (1949 p. 28) also indicates that termite-mound thickets occur in miombo woodland (Wm), Undifferentiated woodland (Wn) and edaphic grassland (g).

In Zambia, *termitaria* vegetation was described separately by habitat including: (i) miombo woodland [Wm] *termitaria*; (ii) Kalahari woodland [Wk] *termitaria*; (iii) mopane woodland [Wo] *termitaria*; (iv) undifferentiated woodland [Wn] *termitaria*; (v) riparian [fr] *termitaria*; and (vi) bush groups. On the Zambian vegetation sheets, *termitaria* vegetation corresponds to mapping unit 16 of "Termitary associated vegetation, and bush groups within grassy drainage zones". This mapping unit is represented on the original map partially by polygons and partially by a point layer (this layer corresponds to small areas of less than 500 m width that were not mapped [by polygons] but [where] their presence was indicated by a smaller overprinted mapping unit number within a circle).

In the description of termitaria vegetation, Fanshawe (1971 p. 61) describes "bush group grassland" as an edaphic grassland type (with characteristic grass species of *Loudetia simplex*) that is found on riverine flats and dambo margins and that has scattered termitaria. However, on the back side of the vegetation sheets of the vegetation map that Fanshawe prepared (Edmonds 1976), "bush groups" are defined as (i) either bush groups that are based on termitaria along the margins of seepage dambo and floodplain (as in Chinsali and Kaoma Districts); (ii) or bush groups that are not based on termitaria but are isolated patches of Kalahari woodland (Wk, original mapping unit 13) on slight elevations surrounded by grassland.

In the VECEA map, we first made the assumption that the polygon parts of the original mapping unit 16 only corresponded to "bush groups within grassy drainage zones". We further assumed that polygons of mapping

11: Gillman (1949) defines intrazonals as vegetation types that occur as a result of rapid alterations of geological, edaphic or anthropogenic conditions under a uniform climate, but that could not be represented on the Tanzanian map.

unit 16 that occurred on Kalahari soils and associated vegetation types of the Trapnell *et al.* (1950) soil - vegetation map corresponded to the isolated patches of Kalahari woodland (Wk) surrounded by grassland. Where polygons of mapping unit did not occur on Kalahari soils, we mapped these areas as mosaics of termitaria on edaphic grasslands ("T/g"; see Volume 6).

In the coastal areas of Kenya and Tanzania, termitaria vegetation was described as Zanzibar-Inhambane termite mounds in seasonally waterlogged grassland (White 1983 p. 189; see also section 8.1).

8.3. Species composition

Species assemblages were obtained from the following references:

- Malawi: Information was obtained from earlier field work of our Malawian colleague (Cornell Dudley, unpublished data). Species listed for "*Colophospermum mopane* clump (*termitaria*) wooded grassland" were coded "x" (unless they were characteristic species).
- Zambia: Fanshawe (1971). Species listed for the species composition table for "*termitaria*" provided on pages 58 to 60 were coded "x" (unless they were characteristic species).
- Coastal areas of Kenya and Tanzania: White (1983 p. 189). Tree species listed to occur on dense thickets on termite-mounds in seasonally waterlogged grassland within the Zanzibar-Inhambane region were coded "C".

Characteristic species were determined as:

- Malawi: Species identified to be present as large trees (20 - 30 m) were coded as "C".
- Zambia: Common species listed for the upper storey of miombo termitaria were coded "Cm", for Kalahari termitaria "Ck", for Mopane termitaria "Co", for Munga termitaria (*i.e.* Undifferentiated woodland [Wn]) "Cn" and for Riparian termitaria "Cr".
- Coastal areas of Kenya and Tanzania: All species were assumed to be characteristic ("C").

Within the information on assemblages, coding "f" indicates that there is information that the species **potentially** occurs in the vegetation type since it occurs in the focal country and in the same bushland type in other countries (see section 2.3).

Table 8.5. Species composition of *termitaria* vegetation (T)

Species	Regional status (see section 2.3)	(Malawi)	(Zambia)	(coast)
Abutilon angulatum		f	x	
Acacia gerrardii			x	f
Acacia nigrescens		x	Co	
Acacia nilotica			x	f
Albizia amara			Cmo	
Albizia anthelmintica		x	x	f
Allophylus africanus		x	x	
Antidesma venosum			x	f
Apodytes dimidiata			Cr	f
Balanites aegyptiaca			x	
Bauhinia petersiana			x	
Berchemia discolor		f	x	f
Boscia angustifolia			Cm	f
Boscia salicifolia			x	f
Capparis tomentosa		f	x	f
Carissa spinarum	widespread species in Zambezian termite-mound thicket		x	f
Cassia abbreviata		x	x	f
Colophospermum mopane	dominant species of Mopane woodland	C	Co	
Combretum imberbe			Ckn	f
Combretum molle			Cm	f
Commiphora africana			x	
Dalbergia melanoxylon		x	x	f
Dichrostachys cinerea			x	f
Diospyros consolatae	thickets on termite mounds			C
Diospyros cornii	emergent trees on termite mounds			C
Diospyros lycioides	widespread species in Zambezian termite-mound thicket		x	
Diospyros mespiliformis		f	Ck	f
Dobera glabra	emergent trees on termite mounds		x	C
Dombeya kirkii		f	x	
Dombeya rotundifolia			x	
Entandrophragma caudatum			x	
Erythrina abyssinica			Cm	f
Erythrophleum suaveolens			Cr	f
Euclea divinorum			x	f
Euclea natalensis	thickets on termite mounds		x	C
Euclea racemosa			x	f
Euphorbia candelabrum	widespread species in Zambezian termite-mound thicket		Cm	f
Ficus sycomorus			x	f
Flacourtia indica			x	f
Flueggea virosa	widespread species in Zambezian termite-mound thicket		x	f
Garcinia livingstonei			Cor	f
Grewia bicolor		x	x	
Kigelia africana		f	x	f
Kirkia acuminata		f	Co	
Landolphia kirkii			x	f
Lannea discolor			x	

Species	Regional status (see section 2.3)	(Malawi)	(Zambia)	(coast)
Lannea schweinfurthii		x	Cno	f
Lonchocarpus capassa		f	x	f
Manilkara mochisia	emergent trees on termite mounds	x	Cn	C
Margaritaria discoidea			x	f
Markhamia obtusifolia			x	f
Markhamia zanzibarica		x	Co	f
Maytenus senegalensis			x	f
Olea europaea	(*Olea europaea* ssp. *cuspidata,* synonym: *Olea africana*)		x	f
Oncoba spinosa			x	
Oxytenanthera abyssinica	(bamboo species indigenous to Africa)		x	
Parinari curatellifolia			Cr	f
Peltophorum africanum	widespread species in Zambezian termite-mound thicket		Cn	f
Phoenix reclinata	palm species		x	f
Phytolacca dodecandra			x	
Piliostigma thonningii			x	f
Psydrax parviflora			x	
Pterocarpus angolensis			x	f
Rhoicissus tridentata	widespread species in Zambezian termite-mound thicket		x	f
Rhus tenuinervis			x	
Schinziophyton rautanenii			x	
Senna singueana			x	f
Sideroxylon inerme	thickets on termite mounds		x	C
Steganotaenia araliacea	widespread species in Zambezian termite-mound thicket		x	
Sterculia africana			Co	f
Sterculia quinqueloba		x	x	f
Strychnos lucens			x	
Strychnos potatorum	widespread species in Zambezian termite-mound thicket		Ckn	
Syzygium cordatum			Cr	f
Syzygium guineense			Cr	f
Tamarindus indica	emergent trees on termite mounds	x	x	C
Thespesia garckeana			Cm	
Uapaca kirkiana			x	
Uapaca nitida			x	f
Uapaca sansibarica			x	f
Vitex doniana			x	f
Ximenia americana			x	f
Zanthoxylum chalybeum			x	f
Ziziphus mucronata		x	Cmno	f

9. Zambezian rupicolous bushland and thicket (edaphic vegetation type, not mapped)

9.1. Description

Rocky outcrops often support a distinctive type of vegetation such as on granite 'kopjes' ('small heads') that occur in the Zambezian region. Several species also occur on termite mounds (White 1983 pp. 98 - 99).

9.2. VECEA region

Within the VECEA region, we did not map Zambezian rupicolous bushland and thicket separately because it was not mapped separately on any of the national maps that we used.. We assume that the vegetation type occurs in Malawi, Tanzania and Zambia as these countries belong (partially) to the Zambezian floristic region.

Gillman (1949 pp. 24-25) indicates that rupiculous bushland and thicket (he uses the synonym of "inselberg vegetation") occur as "intrazonals" (defined as vegetation types that occur as a result of rapid alterations of geological, edaphic or anthropogenic conditions under a uniform climate, but that could not be represented on the map) in woodland.

Rupiculous bushland and thicket also occurs in countries other than Malawi, Tanzania and Zambia. For example, Porembski *et al.* (1997) describe the vegetation of inselbergs, quarzitic outcrops and ferricretes in Rwanda and the east of the Democratic Republic of Congo (former Zaire).

9.3. Species composition

Species assemblages were obtained from the following reference:
White (1983 pp. 98 - 99). Species listed were coded "x".

Characteristic species were not identified

Table 9. Species composition of Zambezian rupicolous bushland and thicket (edaphic vegetation type, not mapped)

Species	Regional status
Afzelia quanzensis	emergents
Bauhinia petersiana	widely distributed smaller trees, bushes and climbers
Canthium burtii	widely distributed smaller trees, bushes and climbers
Canthium lactescens	widely distributed smaller trees, bushes and climbers
Cassia abbreviata	widely distributed smaller trees, bushes and climbers
Diospyros mespiliformis	emergents
Entandrophragma caudatum	emergents
Euclea natalensis	widely distributed smaller trees, bushes and climbers (also Zambezian termite-mound thicket)
Euphorbia candelabrum	widely distributed smaller trees, bushes and climbers (also Zambezian termite-mound thicket)
Kirkia acuminata	emergents
Lannea discolor	widely distributed smaller trees, bushes and climbers
Sclerocarya birrea	emergents
Steganotaenia araliacea	widely distributed smaller trees, bushes and climbers (also Zambezian termite-mound thicket)
Strychnos potatorum	widely distributed smaller trees, bushes and climbers (also Zambezian termite-mound thicket)

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Appendices

Appendix 1. Information on useful tree species

Information on useful tree species was obtained from the following references listing "useful trees and shrub species" for one of the seven VECEA countries: Bekele-Tesemma (2007), Fanshawe (1982), Katende *et al.* (1995), Maundu and Tengnas (2005), Mbuya *et al.* (1994), Nduwayezu *et al.* (2009), Simute *et al.* (1998) and Williamson (1975). From the Williamson (1975) reference, only species were included for which it was mentioned that their wood was used for timber or other purposes.

Table A1. Information on useful tree species that occur in at least one of the bushland potential natural vegetation types. x = species was listed in the reference on useful tree species in the country; f = there is floristic information that the species occurs in the country; w = the only floristic information is from the UNEP-WCMC species database

Species	Ethiopia	Kenya	Malawi	Rwanda	Tanzania	Uganda	Zambia
Abutilon angulatum	f		f	x		f	f
Acacia abyssinica	x	x	f	x	f	x	
Acacia asak	x						
Acacia brevispica	x	x		x	f	f	
Acacia bussei	x	f			f		
Acacia drepanolobium	f	x			f	f	
Acacia elatior		x				f	
Acacia gerrardii	f	x	f	x	f	x	f
Acacia hockii	f	f	f	x	x	x	f
Acacia kirkii		x		x	f	f	f
Acacia lahai	x	x			f	x	
Acacia mellifera	f	x			x	x	f
Acacia nigrescens			x		f		f
Acacia nilotica	x	x	f		x	x	f
Acacia oerfota	x	f			f	f	
Acacia paolii	f	x					
Acacia polyacantha	x	x	x	x	x	f	x
Acacia senegal	x	x		x	x	x	f
Acacia seyal	x	x	f		x	x	f
Acacia sieberiana	x	f	f	x	f	x	x
Acacia tortilis	x	x			x	x	f
Acacia xanthophloea		x	f		x		
Acokanthera oppositifolia		x	f				f
Acokanthera schimperi	x	x		x	x	f	
Adansonia digitata	x	x	f		x		x
Adenium obesum	f	x				x	
Afzelia quanzensis		x	x		x	w	x
Agauria salicifolia	f	f	f	x	w	f	f
Albizia amara	f	x	f	x	x	f	x
Albizia anthelmintica	f	x	f		f	f	f
Albizia antunesiana			f	f	f		x

Species	Ethiopia	Kenya	Malawi	Rwanda	Tanzania	Uganda	Zambia
Albizia coriaria	f	x			f	x	f
Albizia petersiana		f	f	x	f	f	
Albizia zygia		f			f	x	
Allophylus africanus	f	f	f	x	f	f	f
Allophylus rubifolius	f	f	f	x	f	f	f
Annona senegalensis	x	f	f	x	x	x	x
Antidesma venosum	f	x	f		f	f	f
Apodytes dimidiata	x	x	x	x	f	f	f
Balanites aegyptiaca	x	x		f	x	x	x
Balanites glabra	f	x			f		
Balanites rotundifolia	f	x				x	
Baphia massaiensis					f		x
Bauhinia petersiana			f		x		x
Berberis holstii	x	f	f		f	f	
Berchemia discolor	x	x	x		x	f	x
Bersama abyssinica	x	x	f	x	x	x	f
Boscia angustifolia	f	f	w	x	f	f	w
Boscia coriacea	f	x			f	f	
Boscia salicifolia	f	f	f		x	f	f
Boswellia microphylla	f	x					
Boswellia neglecta	f	x			f	f	
Boswellia papyrifera	x	f				f	
Boswellia rivae	x	f					
Brachystegia spiciformis		x	x		x		x
Bridelia brideliifolia			f	x	f	f	
Bridelia micrantha	x	x	x	x	x	x	x
Bridelia scleroneura	f	f		x	f	f	
Buddleja polystachya	x	x			f	f	
Burkea africana		w	x		x	f	x
Cadaba farinosa	w	x		f	x	f	
Calodendrum capense		x	f		x	x	
Calotropis procera	x	f			f	f	
Canthium lactescens	f	f		x	f	f	f
Capparis tomentosa	x	x	f	x	f	f	f
Carissa spinarum	x	x	f	x	x	x	f
Cassia abbreviata		x	f		f		x
Cassipourea malosana	f	x	f		f	f	f
Catha edulis	x	f	f	w	x	x	f
Clausena anisata	f	x	f	x	w	f	f
Clerodendrum myricoides	f	x		f	f	f	
Colophospermum mopane			x				x
Combretum aculeatum	x	x			f	f	
Combretum adenogonium	f	f	f		x	f	f
Combretum collinum	x	x	f	x	f	x	f
Combretum imberbe			x		f		x
Combretum molle	x	x	f	x	x	x	x
Combretum zeyheri		f	x		f		f
Commiphora africana	x	x	f	x	x	x	x
Commiphora erythraea	x						
Commiphora habessinica	x	f		f	f	f	f

Species	Ethiopia	Kenya	Malawi	Rwanda	Tanzania	Uganda	Zambia
Commiphora myrrha	f	x					
Commiphora rostrata	f	x					
Cordeauxia edulis	x	x					
Cordia monoica	f	x			x	x	
Cordia sinensis	f	x			x	x	f
Cornus volkensii		x	f	x	f	f	
Crotalaria agatiflora	f	x	f	f	f	f	
Croton macrostachyus	x	x	f	f	x	x	f
Cussonia arborea	f	f	f	x	x	f	x
Cussonia holstii	f	x		f	f	f	
Dalbergia melanoxylon	x	x	x		x	x	f
Delonix elata	f	x		x	f	f	f
Dichrostachys cinerea	x	x	x	x	x	x	x
Diospyros abyssinica	x	x	f	w	f	x	f
Diospyros mespiliformis	x	x	x		x	x	x
Diospyros scabra	f	x				f	
Diplorhynchus condylocarpon			f				x
Discopodium penninervium	x	f	f	f	f	x	
Dobera glabra	x	x				f	
Dodonaea viscosa	x	x	f	x	x	x	f
Dombeya kirkii	f	f	f	f	f	x	f
Dombeya rotundifolia	f	x	x	x	x	f	x
Dombeya torrida	x	x	w	x	f	x	
Dovyalis abyssinica	x	x	w		f	x	
Dovyalis macrocalyx		x	f	f	f	x	f
Elaeodendron buchananii	f	x	f	x	f	f	f
Embelia schimperi	x	x	f	f	f	f	f
Entada abyssinica	x	x	f	x	x	x	f
Entandrophragma caudatum			x				f
Erica arborea	x	f		f	f	f	
Erythrina abyssinica	x	x	x	x	x	x	x
Erythrina burttii		x			f		
Erythrina melanacantha	f	x			f		
Erythrophleum africanum		w			f	w	x
Erythrophleum suaveolens		f	x		f	x	f
Euclea divinorum	f	x	f	f	x	f	f
Euclea natalensis		f	x		f		f
Euclea racemosa	x	f	f	x	f	f	f
Euphorbia abyssinica	x	f	w		f	f	
Euphorbia candelabrum	x	x	w	x	f	x	w
Euphorbia tirucalli	x	x	f	x	x	x	x
Fagaropsis angolensis	x	x	f	f	x	f	w
Faidherbia albida	x	x	x		x	x	x
Faurea rochetiana	f	f	x	f	f	f	
Faurea saligna		x	x	x	f	x	x
Ficus glumosa	f	f	f	f	f	x	f
Ficus sycomorus	x	x	f	x	x	x	x
Flacourtia indica	x	x	f	x	x	x	x
Flueggea virosa	x	x	f	x	f	f	f
Garcinia buchananii	f	f	w	f	f	x	x

Species	Ethiopia	Kenya	Malawi	Rwanda	Tanzania	Uganda	Zambia
Garcinia livingstonei	f	x	f		x	f	f
Gardenia ternifolia	x	f		x	f	f	
Gardenia volkensii	x	x			f	f	
Grewia bicolor	x	x	f	x	x	x	f
Grewia mollis	f	f		f	f	x	f
Grewia similis	f	f		x	x	f	
Grewia tembensis	f	x					
Grewia tenax	f	x			f	f	
Grewia villosa	x	x			x	f	
Hagenia abyssinica	x	x	f	x	x	x	f
Harrisonia abyssinica	f	x	f	f	f	f	f
Hypericum quartinianum	x	f	f		f	f	f
Hypericum revolutum	x	f	f	x	f	f	f
Hyphaene compressa	f	x			f		
Hyphaene thebaica	x						
Indigofera swaziensis		f			x	f	
Jatropha curcas	x	x	f	x	f	x	f
Juniperus procera	x	x	x		x	x	
Kedrostis gijef		x			f		
Kigelia africana	x	x	x	x	x	x	x
Kirkia acuminata			x		f		x
Landolphia kirkii		x	f		f		f
Lannea alata		x			f		
Lannea discolor			x				x
Lannea fulva		x		x	f	x	
Lannea humilis	f	f		x	f	f	f
Lannea rivae	f	x			f		
Lannea schimperi	f	x	f	x	f	f	f
Lannea schweinfurthii	f	x	x	x	x	x	x
Lannea triphylla	f	x			f	f	
Lawsonia inermis	x	x			x	f	
Lecaniodiscus fraxinifolius	f	x	f		f	f	f
Leptadenia hastata	f	x					
Lippia kituiensis		x			f		
Lonchocarpus capassa			x		x		x
Maerua decumbens	f	x			f	f	
Maesa lanceolata	x	f	x	x	f	x	f
Manilkara mochisia		x	f		f		f
Manilkara sulcata		x			f		
Margaritaria discoidea	f	x	f		f	x	f
Markhamia obtusifolia		f	x	x	f		x
Markhamia zanzibarica		f	x		f	f	f
Maytenus senegalensis	x	x	x	x	f	f	f
Maytenus undata	f	f	f	f	f	x	f
Melia volkensii	f	x			f		
Meyna tetraphylla	f	x			f	f	
Morella salicifolia	x					x	
Moringa oleifera	x	x		x	f	x	x
Moringa stenopetala	w	x					
Myrsine africana	f	x	f	f	f	f	f

Species	Ethiopia	Kenya	Malawi	Rwanda	Tanzania	Uganda	Zambia
Newtonia hildebrandtii		x			f		f
Nuxia congesta	x	x	x	x	f	x	f
Olea capensis	x	x	f	f	x	x	f
Olea europaea	x	x	x	x	x	x	f
Olinia rochetiana	x	f	f	x	f	x	f
Oncoba spinosa	x	x	x		f	f	f
Opilia campestris	f	x			f		
Ormocarpum kirkii		x	f		f		f
Ormocarpum trachycarpum	f	f			x	f	
Ormocarpum trichocarpum	f	f	f	x	f	f	
Osyris lanceolata	f	x		x	x	f	
Otostegia integrifolia	x						
Oxytenanthera abyssinica	x		x		x	x	x
Ozoroa insignis	f	x	x	x	x	x	f
Pappea capensis	f	x	f	x	x	f	f
Parinari curatellifolia		x	x	x	x	x	x
Parkinsonia aculeata	x	x			x	x	
Pavetta crassipes	f	x			f	f	
Pavetta oliveriana	x	f		f	f	f	
Pericopsis angolensis			x	f	x		x
Phoenix dactylifera	x	x			f		
Phoenix reclinata	x	x	w	x	x	x	x
Phytolacca dodecandra	x	f	f	f	f	x	f
Piliostigma thonningii	x	x	x	f	x	x	x
Pistacia aethiopica	f	x			f	f	
Pittosporum viridiflorum	x	f	f	f	f	x	f
Plectranthus barbatus	f	x			f	f	
Pleurostylia africana		f	f	x	f	f	f
Podocarpus latifolius		x	x	x	x	x	f
Populus ilicifolia		x			w		
Premna resinosa	f	x			f	f	
Prunus africana	x	x	x	x	x	x	f
Pseudolachnostylis maprounei-folia			f		x		x
Psydrax parviflora	f	f	f	x	f	f	f
Psydrax schimperiana	x	f	f	x	f	f	f
Pterocarpus angolensis			x		x		x
Pterolobium stellatum	f	f	f	x	f	f	f
Rapanea melanophloeos	f	f	f	x	f	x	f
Rhamnus prinoides	x	f	f	x	f	f	f
Rhamnus staddo	x	x		f	f	f	
Rhoicissus revoilii	x	f	f	f	f	f	f
Rhoicissus tridentata	x	x	f	f	f	f	f
Rhus glutinosa	x						
Rhus longipes	f	f	f	x	f	f	f
Rhus natalensis	x	x	f	x	f	f	f
Rhus tenuinervis	f	x	f		f		f
Rhus vulgaris	x	x	f	f	f	f	f
Rosa abyssinica	x						
Rubus volkensii	f	x			f	f	
Saba comorensis	f	x					

Species	Ethiopia	Kenya	Malawi	Rwanda	Tanzania	Uganda	Zambia
Salvadora persica	x	x	f		x	f	f
Schinziophyton rautanenii			x		f		x
Schrebera alata	f	x	f	f	f	x	f
Sclerocarya birrea	x	x	x		x	x	x
Scutia myrtina	f	x	f	x	f	f	f
Searsia retinorrhoea	x						
Securidaca longipedunculata	x	f	f	f	x	x	f
Senecio hadiensis	f	f		f	f	x	
Senna alexandrina	x	f					
Senna didymobotrya	x	f	f	x	f	x	f
Senna septemtrionalis		f	f	x	f	f	f
Senna singueana	f	x	f	x	f	f	x
Sideroxylon inerme		x			f		
Sinarundinaria alpina	x	x	x	x	f	x	
Solanecio cydoniifolius		f		f	f	x	
Solanecio mannii	f	x	w	f	f	x	w
Solanum aculeastrum		f	f	f	f	x	
Spirostachys venenifera		x			f		
Steganotaenia araliacea	x	f	f	f	f	x	f
Sterculia africana	x	x	f		x		x
Sterculia quinqueloba			x	f	x		x
Stereospermum kunthianum	x	x	f		x	x	f
Strychnos henningsii	x	x	f		f	f	f
Strychnos innocua	x	f	f	x	x	x	x
Strychnos lucens			f	x	f		f
Syzygium cordatum		x	x	f	x	x	x
Syzygium guineense	x	x	x	x	x	x	x
Tamarindus indica	x	x	x		x	x	x
Tamarix aphylla	x	f					
Tamarix nilotica	f	x			f		
Tarenna graveolens	f	f		x	f	f	
Tephrosia vogelii		f	f	x	f	f	x
Terminalia brownii	x	x			x	x	
Terminalia mollis		x		f	f	f	f
Terminalia orbicularis	f	x					
Terminalia prunioides	f	x			f		f
Terminalia sericea			x		x		x
Terminalia spinosa	f	x			x	f	
Tetradenia riparia	f	x		f			
Thespesia garckeana		f	f		x		x
Thylachium thomasii		x					
Uapaca kirkiana			x		x		x
Uapaca nitida			x		f		x
Uapaca sansibarica			f		f	f	x
Uvaria scheffleri		x			f	f	
Vangueria apiculata	f	x	f	x	f	f	f
Vangueria infausta		x	f	x	x	f	f
Vangueria madagascariensis	f	x	f		x	f	
Vepris nobilis	x	x	f	x	x	x	f
Vitex doniana	x	x	x	f	f	x	x

Species	Ethiopia	Kenya	Malawi	Rwanda	Tanzania	Uganda	Zambia
Vitex mombassae		x			x		
Warburgia ugandensis	x	x	f		x	x	
Woodfordia uniflora	x	f				f	
Ximenia americana	x	x	x	x	x	x	x
Zanthoxylum chalybeum	f	x	f	x	x	x	f
Zanthoxylum usambarense	f	x		f	f		
Ziziphus abyssinica	f	x	f	f	f	x	x
Ziziphus mauritiana	x	x	f		x	f	x
Ziziphus mucronata	x	x	f	x	x	f	f
Ziziphus pubescens	x	f	f		f	f	f
Ziziphus spina-christi	x	f			f	f	

Appendix 2. Information on synonyms

We used a consistent naming system for all the species that were listed in this volume. The table immediately below shows how we reclassified some of the species that we encountered in national references. Note that we did not always use the most current name (mainly as a result of trying to use the same names of species listed in the Plant Resources of Tropical Africa (PROTA) database (URL *http://www.prota4u.org/*).

Table A2. Correspondence between species names as listed in the VECEA documentation and some synonyms of these species

Synonym	Species in VECEA
Acacia albida	*Faidherbia albida*
Acacia giraffae	*Acacia erioloba*
Acacia nubica	*Acacia oerfota*
Acacia oliveri	*Acacia senegal*
Adhatoda schimperiana	*Justicia schimperiana*
Adina microcephala	*Breonadia salicina*
Afrocarpus dawei	*Podocarpus usambarensis*
Afrocarpus gracilior	*Podocarpus falcatus*
Afrocrania volkensii	*Cornus volkensii*
Afrosersalisia cerasifera	*Synsepalum cerasiferum*
Agarista salicifolia	*Agauria salicifolia*
Albizia fastigiata	*Albizia adianthifolia*
Albizia maraguensis	*Albizia schimperiana*
Aningeria adolfi-friedericii	*Pouteria adolfi-friedericii*
Aningeria altissima	*Pouteria altissima*
Aningeria pseudoracemosa	*Pouteria pseudoracemosa*
Annona chrysophylla	*Annona senegalensis*
Anthocleista zambesiaca	*Anthocleista grandiflora*
Antiaris usambarensis	*Antiaris toxicaria*
Arundinaria alpina	*Sinarundinaria alpina*
Azanza garckeana	*Thespesia garckeana*
Bauhinia macrantha	*Bauhinia petersiana*
Bauhinia thonningii	*Piliostigma thonningii*
Bequaertiodendron natalense	*Englerophytum natalense*
Blepharis caloneura	*Blepharis maderaspatensis*
Breonadia microcephala	*Breonadia salicina*
Bridelia scleeroneuroides	*Bridelia scleroneura*
Byrsocarpus orientalis	*Rourea orientalis*
Canthium frangula	*Canthium glaucum*
Canthium rubrocostatum	*Psydrax parviflora*
Canthium schimperanum	*Psydrax schimperiana*
Canthium vulgare	*Psydrax parviflora*
Carapa grandiflora	*Carapa procera*
Carissa edulis	*Carissa spinarum*
Cassia didymobotrya	*Senna didymobotrya*
Cassia floribunda	*Senna septemtrionalis*
Cassine buchananii	*Elaeodendron buchananii*
Cassipourea celliottii	*Cassipourea malosana*
Cassipourea congensis	*Cassipourea malosana*

Synonym	Species in VECEA
Cassipourea ruwensorensis	*Cassipourea ruwensoriensis*
Celtis durandii	*Celtis gomphophylla*
Celtis wightii	*Celtis philippensis*
Cephaelis peduncularis	*Psychotria peduncularis*
Chlorophora excelsa	*Milicia excelsa*
Cleistanthus milleri	*Cleistanthus polystachyus*
Cola microcarpa	*Cola greenwayi*
Coleus barbatus	*Plectranthus barbatus*
Combretum binderianum	*Combretum collinum*
Combretum mechowianum	*Combretum collinum*
Commiphora zimmermannii	*Commiphora eminii*
Conopharyngia holstii	*Tabernaemontana pachysiphon*
Cordia ovalis	*Cordia monoica*
Cordia rothii	*Cordia sinensis*
Crassocephalum mannii	*Solanecio mannii*
Cryptosepalum pseudotaxus	*Cryptosepalum exfoliatum*
Cylicodiscus battiscombei	*Newtonia paucijuga*
Diospyros bussei	*Diospyros consolatae*
Dodonaea angustifolia	*Dodonaea viscosa*
Dombeya bagshawei	*Dombeya buettneri*
Dombeya goetzenii	*Dombeya torrida*
Dombeya leucoderma	*Dombeya torrida*
Dombeya mukole	*Dombeya kirkii*
Dovyalis engleri	*Dovyalis abyssinica*
Ekebergia rueppelliana	*Ekebergia capensis*
Ekebergia senegalensis	*Ekebergia capensis*
Erythrina tomentosa	*Erythrina abyssinica*
Erythrophleum guineense	*Erythrophleum suaveolens*
Euclea latidens	*Euclea racemosa*
Euclea schimperi	*Euclea racemosa*
Eugenia bukobensis	*Eugenia capensis*
Euphorbia obovalifolia	*Euphorbia abyssinica*
Excoecaria venenifera	*Spirostachys venenifera*
Fagara chalybea	*Zanthoxylum chalybeum*
Ficus burkei	*Ficus thonningii*
Ficus capensis	*Ficus sur*
Ficus congensis	*Ficus trichopoda*
Ficus dekdekana	*Ficus thonningii*
Funtumia latifolia	*Funtumia africana*
Gardenia jovis-tonantis	*Gardenia ternifolia*
Gardenia spatulifolia	*Gardenia volkensii*
Grewia platyclada	*Grewia flavescens*
Grumilea megistosticta	*Psychotria mahonii*
Hagenia anthelmintica	*Hagenia abyssinica*
Haplocoelum gallaense	*Haplocoelum foliolosum*
Harrisonia occidentalis	*Harrisonia abyssinica*
Heeria reticulata	*Ozoroa insignis*
Hexalobus monopetalanthus	*Hexalobus monopetalus*
Hippocratea parvifolia	*Loeseneriella parvifolia*
Hypericum keniense	*Hypericum revolutum*
Hypericum lanceolatum	*Hypericum revolutum*

Synonym	Species in VECEA
Hyphaene parvula	*Hyphaene coriacea*
Hyphaene ventricosa	*Hyphaene petersiana*
Hypoestes verticillaris	*Hypoestes forskaolii*
Iboza riparia	*Tetradenia riparia*
Khaya nyasica	*Khaya anthotheca*
Kigelia aethiopum	*Kigelia africana*
Lannea stuhlmannii	*Lannea schweinfurthii*
Lepisanthes senegalensis	*Aphania senegalensis*
Lovoa brownii	*Lovoa trichilioides*
Macaranga kilimandscharica	*Macaranga capensis*
Macaranga pynaertii	*Macaranga spinosa*
Maerua edulis	*Maerua decumbens*
Maerua subcordata	*Maerua decumbens*
Markhamia acuminata	*Markhamia zanzibarica*
Markhamia platycalyx	*Markhamia lutea*
Memecylon buchananii	*Warneckea sansibarica*
Memecylon sansibaricum	*Warneckea sansibarica*
Mimusops fruticosa	*Mimusops obtusifolia*
Mimusops ugandensis	*Mimusops bagshawei*
Mitragyna rubrostipulata	*Hallea rubrostipulata*
Mitragyna stipulosa	*Hallea stipulosa*
Mondia whytei	*Mondia whitei*
Morus excelsa	*Milicia excelsa*
Myrsine melanophloeos	*Rapanea melanophloeos*
Nesogordonia parvifolia	*Nesogordonia holtzii*
Nuxia usambarensis	*Nuxia floribunda*
Ochna longipes	*Ochna holstii*
Olea africana	*Olea europaea*
Olea chrysophylla	*Olea europaea*
Olea hochstetteri	*Olea capensis*
Olea welwitschii	*Olea capensis*
Olinia usambarensis	*Olinia rochetiana*
Ostryoderris stuhlmannii	*Xeroderris stuhlmannii*
Osyris abyssinica	*Osyris lanceolata*
Osyris compressa	*Osyris lanceolata*
Ozoroa reticulata	*Ozoroa insignis*
Pachystela brevipes	*Synsepalum brevipes*
Pachystela msolo	*Synsepalum msolo*
Phyllanthus discoideus	*Margaritaria discoidea*
Piptadeniastrum buchananii	*Newtonia buchananii*
Pittosporum malosanum	*Pittosporum viridiflorum*
Pittosporum mildbraedii	*Pittosporum viridiflorum*
Pittosporum rhodesicum	*Pittosporum viridiflorum*
Pittosporum spathicalyx	*Pittosporum viridiflorum*
Plectronia schimperiana	*Psydrax schimperiana*
Podocarpus gracilior	*Podocarpus falcatus*
Podocarpus milanjianus	*Podocarpus latifolius*
Popowia obovata	*Friesodielsia obovata*
Pterocarpus antunesii	*Pterocarpus lucens*
Pterocarpus holstii	*Pterocarpus tinctorius*
Pterocarpus stolzii	*Pterocarpus tinctorius*

Synonym	Species in VECEA
Pterolobium lacerans	*Pterolobium stellatum*
Pygeum africanum	*Prunus africana*
Rapanea pulchra	*Rapanea melanophloeos*
Rauvolfia inebriens	*Rauvolfia caffra*
Rauvolfia obliquinervis	*Rauvolfia caffra*
Rauvolfia oxyphylla	*Rauvolfia caffra*
Rhodognaphalon schumannianum	*Bombax rhodognaphalon*
Rhoicissus erythrodes	*Rhoicissus tridentata*
Rinorea ardisiiflora	*Rinorea angustifolia*
Rinorea gracilipes	*Rinorea angustifolia*
Rubus rigidus	*Rubus apetalus*
Sambucus africana	*Sambucus ebulus*
Sapium bussei	*Excoecaria bussei*
Sapium ellipticum	*Shirakiopsis elliptica*
Sclerocarya caffra	*Sclerocarya birrea*
Scutia commersonii	*Scutia myrtina*
Securinega virosa	*Flueggea virosa*
Senecio mannii	*Solanecio mannii*
Sideroxylon diospyroides	*Sideroxylon inerme*
Smilax kraussiana	*Smilax anceps*
Strychnos mellodora	*Strychnos mitis*
Syzygium parvifolium	*Syzygium guineense*
Tabernaemontana angolensis	*Tabernaemontana pachysiphon*
Tabernaemontana holstii	*Tabernaemontana pachysiphon*
Tabernaemontana johnstonii	*Tabernaemontana stapfiana*
Teclea fischeri	*Vepris trichocarpa*
Teclea nobilis	*Vepris nobilis*
Teclea simplicifolia	*Vepris simplicifolia*
Teclea trichocarpa	*Vepris trichocarpa*
Terminalia aemula	*Terminalia sambesiaca*
Trema guineensis	*Trema orientalis*
Trichilia volkensii	*Lepidotrichilia volkensii*
Trichocladus malosanus	*Trichocladus ellipticus*
Vangueria acutiloba	*Vangueria madagascariensis*
Vernonia ampla	*Vernonia myriantha*
Vitex amboniensis	*Vitex ferruginea*
Xeromphis nilotica	*Catunaregam nilotica*
Ximenia caffra	*Ximenia americana*

Appendix 3. Information on botanical families

Table A3. Species arranged by family or subfamily (species from the Fabaceae family were listed separately for the ***Caesalpinioideae, Mimosoideae*** and ***Papilionoideae*** subfamilies)

Family	Species
Acanthaceae	*Ecbolium amplexicaule*
	Thunbergia guerkeana
Amaranthaceae	*Sericocomopsis hildebrandtii*
	Sericocomopsis pallida
Anacardiaceae	*Lannea alata*
	Lannea discolor
	Lannea fulva
	Lannea humilis
	Lannea rivae
	Lannea schimperi
	Lannea schweinfurthii
	Lannea triphylla
	Ozoroa insignis
	Pistacia aethiopica
	Rhus glutinosa
	Rhus longipes
	Rhus natalensis
	Rhus tenuinervis
	Rhus vulgaris
	Sclerocarya birrea
	Searsia retinorrhoea
Annonaceae	*Annona senegalensis*
	Uvaria scheffleri
Apiaceae	*Steganotaenia araliacea*
Apocynaceae	*Acokanthera oppositifolia*
	Acokanthera schimperi
	Adenium obesum
	Carissa spinarum
	Diplorhynchus condylocarpon
	Landolphia kirkii
	Saba comorensis
Araliaceae	*Cussonia arborea*
	Cussonia holstii
Arecaceae	*Hyphaene compressa*
	Hyphaene thebaica
	Phoenix dactylifera
	Phoenix reclinata
Asclepiadaceae	*Calotropis procera*
	Leptadenia hastata
	Pergularia daemia
	Sarcostemma viminale
Asteraceae	*Artemisia afra*
	Aspilia mossambicensis
	Bothriocline glomerata
	Conyza newii

Family	Species
Asteraceae	*Helichrysum formosissimum*
	Inula confertiflora
	Psiadia punctulata
	Senecio hadiensis
	Senecio maranguensis
	Senecio mariettae
	Senecio myriocephalus
	Solanecio cydoniifolius
	Solanecio gigas
	Solanecio mannii
	Tarchonanthus camphoratus
	Vernonia brachycalyx
Balanitaceae	*Balanites aegyptiaca*
	Balanites glabra
	Balanites rotundifolia
Berberidaceae	*Berberis holstii*
Bignoniaceae	*Kigelia africana*
	Markhamia obtusifolia
	Markhamia zanzibarica
	Stereospermum kunthianum
Bombacaceae	*Adansonia digitata*
Boraginaceae	*Cordia monoica*
	Cordia sinensis
Burseraceae	*Boswellia microphylla*
	Boswellia neglecta
	Boswellia papyrifera
	Boswellia rivae
	Commiphora africana
	Commiphora campestris
	Commiphora edulis
	Commiphora erythraea
	Commiphora habessinica
	Commiphora mollis
	Commiphora myrrha
	Commiphora rostrata
	Commiphora schimperi
Canellaceae	*Warburgia ugandensis*
Capparidaceae	*Boscia angustifolia*
	Boscia coriacea
	Boscia salicifolia
	Cadaba farinosa
	Cadaba heterotricha
	Capparis fascicularis
	Capparis tomentosa
	Maerua decumbens
	Maerua deinhardtiorum
	Maerua triphylla
	Thylachium thomasii
Celastraceae	*Catha edulis*
	Elaeodendron buchananii

Family	Species
	Maytenus heterophylla
	Maytenus senegalensis
	Maytenus undata
	Pleurostylia africana
Chrysobalanaceae	*Parinari curatellifolia*
Clusiaceae	*Garcinia buchananii*
	Garcinia livingstonei
	Hypericum quartinianum
	Hypericum revolutum
Combretaceae	*Combretum aculeatum*
	Combretum adenogonium
	Combretum celastroides
	Combretum collinum
	Combretum imberbe
	Combretum molle
	Combretum zeyheri
	Pteleopsis anisoptera
	Terminalia brownii
	Terminalia mollis
	Terminalia orbicularis
	Terminalia parvula
	Terminalia prunioides
	Terminalia sericea
	Terminalia spinosa
Connaraceae	*Burttia prunoides*
Cornaceae	*Cornus volkensii*
Cucurbitaceae	*Gerrardanthus lobatus*
	Kedrostis gijef
Cupressaceae	*Juniperus procera*
	Widdringtonia nodiflora
Dracaenaceae	*Dracaena ellenbeckiana*
Ebenaceae	*Diospyros abyssinica*
	Diospyros consolatae
	Diospyros cornii
	Diospyros lycioides
	Diospyros mespiliformis
	Diospyros scabra
	Euclea divinorum
	Euclea natalensis
	Euclea racemosa
Ericaceae	*Agauria salicifolia*
	Erica arborea
	Erica austronyassana
	Erica benguelensis
	Erica excelsa
	Erica johnstoniana
	Erica johnstonii
	Erica kingaensis
	Erica milanjiana
	Erica trimera

Family	Species
	Erica whyteana
Euphorbiaceae	*Acalypha chirindica*
Euphorbiaceae	*Antidesma venosum*
	Bridelia brideliifolia
	Bridelia micrantha
	Bridelia scleroneura
	Bridelia taitensis
	Clutia lanceolata
	Croton dichogamus
	Croton macrostachyus
	Drypetes gerrardii
	Erythrococca bongensis
	Euphorbia abyssinica
	Euphorbia bilocularis
	Euphorbia candelabrum
	Euphorbia dawei
	Euphorbia grandicornis
	Euphorbia nyikae
	Euphorbia quinquecostata
	Euphorbia robecchii
	Euphorbia scheffleri
	Euphorbia tirucalli
	Flueggea virosa
	Givotia gosai
	Jatropha curcas
	Margaritaria discoidea
	Monadenium invenustum
	Pseudolachnostylis maprouneifolia
	Schinziophyton rautanenii
	Spirostachys venenifera
	Uapaca kirkiana
	Uapaca nitida
	Uapaca sansibarica
Flacourtiaceae	*Dovyalis abyssinica*
	Dovyalis macrocalyx
	Flacourtia indica
	Oncoba spinosa
Icacinaceae	*Apodytes dimidiata*
	Pyrenacantha malvifolia
Lamiaceae	*Erythrochlamys spectabilis*
	Leonotis ocymifolia
	Otostegia integrifolia
	Otostegia tomentosa
	Plectranthus barbatus
	Tetradenia riparia
	Tinnea aethiopica
Leguminosae: Caesalpinioideae	*Afzelia quanzensis*
	Bauhinia petersiana
	Bauhinia taitensis
	Brachystegia spiciformis

Family	Species
	Burkea africana
	Bussea massaiensis
	Caesalpinia trothae
Leguminosae: Caesalpinioideae	*Cassia abbreviata*
	Colophospermum mopane
	Cordeauxia edulis
	Delonix elata
	Erythrophleum africanum
	Erythrophleum suaveolens
	Parkinsonia aculeata
	Peltophorum africanum
	Piliostigma thonningii
	Pterolobium stellatum
	Senna alexandrina
	Senna didymobotrya
	Senna septemtrionalis
	Senna singueana
	Tamarindus indica
Leguminosae: Mimosoideae	*Acacia abyssinica*
	Acacia asak
	Acacia brevispica
	Acacia bussei
	Acacia drepanolobium
	Acacia elatior
	Acacia gerrardii
	Acacia hockii
	Acacia kirkii
	Acacia lahai
	Acacia mellifera
	Acacia nigrescens
	Acacia nilotica
	Acacia oerfota
	Acacia paolii
	Acacia polyacantha
	Acacia reficiens
	Acacia senegal
	Acacia seyal
	Acacia sieberiana
	Acacia thomasii
	Acacia tortilis
	Acacia xanthophloea
	Albizia amara
	Albizia anthelmintica
	Albizia antunesiana
	Albizia coriaria
	Albizia petersiana
	Albizia zygia
	Dichrostachys cinerea
	Entada abyssinica
	Faidherbia albida

Family	Species
	Newtonia hildebrandtii
	Pseudoprosopis fischeri
Leguminosae: Papilionoideae	*Adenocarpus mannii*
	Aeschynomene abyssinica
Leguminosae: Papilionoideae	*Baphia burttii*
	Baphia massaiensis
	Craibia brevicaudata
	Crotalaria agatiflora
	Dalbergia melanoxylon
	Erythrina abyssinica
	Erythrina burttii
	Erythrina melanacantha
	Indigofera swaziensis
	Kotschya recurvifolia
	Lonchocarpus capassa
	Ormocarpum kirkii
	Ormocarpum trachycarpum
	Ormocarpum trichocarpum
	Pericopsis angolensis
	Platycelyphium voense
	Pterocarpus angolensis
	Pterocarpus rotundifolius
	Tephrosia aequilata
	Tephrosia vogelii
Liliaceae	*Aloe arborescens*
	Aloe kedongensis
	Asparagus africanus
	Asparagus racemosus
Lobeliaceae	*Lobelia rhynchopetalum*
	Lobelia stuhlmannii
Loganiaceae	*Buddleja polystachya*
	Nuxia congesta
	Strychnos henningsii
	Strychnos innocua
	Strychnos lucens
	Strychnos potatorum
Lythraceae	*Lawsonia inermis*
	Woodfordia uniflora
Malphigiaceae	*Caucanthus albidus*
Malvaceae	*Abutilon angulatum*
	Pavonia urens
	Thespesia garckeana
	Entandrophragma caudatum
	Melia volkensii
	Turraea mombassana
	Turraea nilotica
Melianthaceae	*Bersama abyssinica*
Moraceae	*Ficus glumosa*
	Ficus sycomorus
Moringaceae	*Moringa oleifera*

Family	Species
	Moringa stenopetala
Myricaceae	*Morella salicifolia*
Myrsinaceae	*Embelia schimperi*
	Maesa lanceolata
	Myrsine africana
Myrsinaceae	*Rapanea melanophloeos*
Myrtaceae	*Syzygium cordatum*
	Syzygium guineense
Olacaceae	*Ximenia americana*
	Olea capensis
	Olea europaea
	Schrebera alata
Oliniaceae	*Olinia rochetiana*
Opiliaceae	*Opilia campestris*
Passifloraceae	*Adenia globosa*
Pedaliaceae	*Sesamothamnus rivae*
Phytolaccaceae	*Phytolacca dodecandra*
Pittosporaceae	*Pittosporum abyssinicum*
	Pittosporum viridiflorum
Poaceae	*Eragrostis nindensis*
	Oxytenanthera abyssinica
	Sinarundinaria alpina
Podocarpaceae	*Podocarpus latifolius*
Polygalaceae	*Securidaca longipedunculata*
Portulacaceae	*Calyptrotheca somalensis*
	Calyptrotheca taitensis
Proteaceae	*Faurea rochetiana*
	Faurea saligna
Ranunculaceae	*Clematis hirsuta*
	Clematis simensis
Rhamnaceae	*Berchemia discolor*
	Rhamnus prinoides
	Rhamnus staddo
	Scutia myrtina
	Ziziphus abyssinica
	Ziziphus mauritiana
	Ziziphus mucronata
	Ziziphus pubescens
	Ziziphus spina-christi
Rhizophoraceae	*Cassipourea malosana*
Rosaceae	*Hagenia abyssinica*
	Prunus africana
	Rosa abyssinica
	Rubus volkensii
Rubiaceae	*Canthium burtii*
	Canthium keniense
	Canthium lactescens
	Carphalea glaucescens
	Galium ruwenzoriense
	Gardenia ternifolia

Family	Species
	Gardenia volkensii
	Hymenodictyon parvifolium
	Meyna tetraphylla
	Pavetta crassipes
	Pavetta oliveriana
	Psydrax parviflora
Rubiaceae	*Psydrax schimperiana*
	Rytigynia umbellulata
	Tapiphyllum obtusifolium
	Tarenna graveolens
	Tarenna neurophylla
	Vangueria apiculata
	Vangueria infausta
	Vangueria madagascariensis
Rutaceae	*Calodendrum capense*
	Clausena anisata
	Fagaropsis angolensis
	Toddalia asiatica
	Vepris nobilis
	Vepris simplicifolia
	Vepris trichocarpa
	Zanthoxylum chalybeum
	Zanthoxylum usambarense
Salicaceae	*Populus ilicifolia*
Salvadoraceae	*Azima tetracantha*
	Dobera glabra
	Dobera loranthifolia
	Salvadora persica
Santalaceae	*Osyris lanceolata*
Sapindaceae	*Allophylus africanus*
	Allophylus rubifolius
	Dodonaea viscosa
	Haplocoelum foliolosum
	Lecaniodiscus fraxinifolius
	Pappea capensis
Sapotaceae	*Manilkara mochisia*
	Manilkara sulcata
	Sideroxylon inerme
Scrophulariaceae	*Halleria lucida*
Simaroubaceae	*Brucea antidysenterica*
	Harrisonia abyssinica
	Kirkia acuminata
Solanaceae	*Discopodium eremanthum*
	Discopodium penninervium
	Solanum aculeastrum
Sterculiaceae	*Dombeya burgessiae*
	Dombeya kirkii
	Dombeya rotundifolia
	Dombeya torrida
	Sterculia africana

Family	Species
	Sterculia quinqueloba
	Sterculia rhynchocarpa
	Sterculia stenocarpa
Tamaricaceae	*Tamarix aphylla*
	Tamarix nilotica
Thymelaeaceae	*Gnidia glauca*
	Gnidia subcordata
Thymelaeaceae	*Struthiola thomsonii*
Tiliaceae	*Grewia bicolor*
	Grewia burttii
	Grewia fallax
	Grewia mollis
	Grewia similis
	Grewia tembensis
	Grewia tenax
	Grewia villosa
	Sparrmannia ricinocarpa
Verbenaceae	*Clerodendrum myricoides*
	Lippia kituiensis
	Premna hildebrandtii
	Premna resinosa
	Vitex doniana
	Vitex mombassae
Vitaceae	*Cissus quadrangularis*
	Cissus rotundifolia
	Rhoicissus revoilii
	Rhoicissus tridentata

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Forest & Landscape
University of Copenhagen
Rolighedsvej 23
1958 Fredriksberg C
Tel. 3533 1500
sl@life.ku.dk
www.sl.life.ku.dk

National centre for research, education and advisory services within the fields of forest and forest products, landscape architecture and landscape management, urban planning and urban design